Independent Science Advisors= Review: Coachella Valley Multiple Species Habitat Conservation Plan/ Natural Communities Conservation Plan (MSHCP/NCCP)

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This report constitutes the peer review of the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Communities Conservation Plan (MSHCP/NCCP) by a group of independent science advisors. Three of the reviewersCReed Noss, Michael Soulé, and Dick TracyCparticipated previously as peer reviewers of early phases of the planning process in the Coachella Valley at two workshops organized by the Coachella Valley Mountains Conservancy, in 1996 and 1998. We otherwise played no role in the development of this plan until being convened for this review. Two additional advisors, Robert Fisher and Robert McKernan, participated in a workshop (described below) on Feb. 12-13, 2001, but did not join in the writing of this review.

We were provided a list of 32 questions under which to organize our review. The questions were developed by the U.S. Fish and Wildlife Service, California Department of Fish and Game, the Coachella Valley Mountains Conservancy , and the Coachella Valley Association of Governments, and grouped into sections considering general habitat and landscape issues, species issues, habitat monitoring and adaptive management, geomorphology, and species modeling (Appendix 1). A draft set of questions was revised in response to comments by Mike O=Connell, Reed Noss, and others. Although we used these questions to organize our comments in this report, in many cases we found that currently available data do not allow usCor probably anyoneCto answer the stated question effectively. In several cases we lumped related questions for the sake of efficiency.

In conducting our review we referred to several documents and a substantial series of maps prepared by the Coachella Valley Mountains Conservancy with the assistance of the participating agencies. The primary document was the January 2001 Administrative Review Draft (ARD) of the Coachella Valley MSHCP/NCCP. Supplementary documents included a Technical Appendix, a document on Species Distribution Model Parameters and Known Locations, an Adaptive Management and Monitoring Program, and the Coachella Valley Draft Water Management Plan. Maps included general geographical information, vegetation (including historic for a portion of the study area), plan alternatives, a species richness and ecological diversity model, and species distribution models. We benefited tremendously from a workshop held in Palm Desert on February 12-13, 2001, during which members of the Science Advisory Committee (SAC) which developed the core of the plan, the Coachella Valley Mountains Conservancy, and other participating agencies presented the conceptual approach, major data, and assumptions underlying the plan to our team of reviewers and responded to our questions. Our review team then met separately for the second day of the workshop, discussed our initial responses to the questions, and made assignments to our individual members to take the lead on particular questions.

Although we are technically individual science advisors and reviewers, this review represents a consensus and the collective opinion of our team. This report consists of two sections: 1) a brief overview stating our general impressions of the draft plan and its three biological alternatives; and 2) responses to the specific questions provided to us by the agencies and planners.

We also want to note that we are explicitly aware that the success of the Coachella Valley MSHCP will depend not only on a scientifically-supported conservation program but one that can be implemented successfully given socioeconomic and political constraints. Our comments in this document are made with the knowledge that these other factors may weigh heavily on the final conservation plan. The primary task of the planning team is to weigh the conservation program against these issues. It is our firm belief, however, that the biological conservation program itself B particularly as reflected in the alternatives B should not be compromised in its initial stages based on estimations of the political economy of the planning area. It is essential that a supportable biological alternative be offered that can be evaluated in the context of politics and economics. It is with this perspective in mind that we offer our comments.

General Impressions of the Plan and Its Alternatives

First, we want to commend the Scientific Advisory Committee (SAC) and others who contributed to the Draft Plan for producing what is sure to be one of the most scientifically defensible and thorough HCPs or NCCPs ever developed. Although our comments in this review take the form of a critique, as they must in order to constitute a substantive review, we do not mean to imply failure on the part of the planners. We recognize that substantial effort and analysis have gone into the Draft Plan, and in our view it has no fatal flaws. Our comments are meant instead to point out areas where the plan can be shored up or improved based on our collective knowledge and review of the technical documents.

The main stimulus for the Coachella Valley MCHCP/NCCP is the requirement under Section 10(a) of the U.S. Endangered Species Act for a habitat conservation plan to be approved before Aincidental take@ of listed species on private lands is permitted. The ongoing conversion of natural habitats within the Coachella Valley to other land uses and the consequent reduction in acreage and alteration of the structure and processes of those habitats has placed many species at risk of extinction. To be effective, the Plan must identify the species at risk, their distributions, and the factors necessary to maintain their essential habitats. The Plan must also include a means to preserve and manage those species and their habitats together with the geophysical and biological factors that maintain them. Because the Plan is not just a MSHCP, but also a NCCP, it must provide a means to conserve the natural communities of the Plan area, not just an assortment of individual species.

On a continental scale, the Coachella Valley is a hot spot of biodiversity, distinguished by high endemism, rarity, and richness of several taxa. For example, researchers with The Nature Conservancy and the Association for Biodiversity Information identified this portion of southern California as one of six regions in the United States that rank in the top tier of conservation priority based on a rarity-weighted richness index (S. Chaplin et al. 2000, Chapter 6 in *Precious Heritage: The Status of Biodiversity in the United States*, Oxford University Press). Common sense suggests that one should not develop or impact resources in a hot spot, because the chances for conflict with conservation objectives are extremely high. Neither common sense nor a conservation ethic has prevailed in past land-use decisions, however. In the case of the Coachella Valley, the most important habitats for biodiversity are largely private land and very expensive, many have been developed for decades, and the pace of development remains rapid. A credible conservation plan for the Coachella Valley will be difficult to forge but is required to resolve continuing conflicts.

We agree in principle with the general planning paradigm of the SAC, i.e., that any action taken in the Plan, for example, establishment of a conservation area or corridor, must be both sufficient and essential (C. Barrows, pers. comm.). We interpret Asufficient@ to mean that it will assure the stated goal or objective (e.g., maintenance of viable populations of covered species) and Aessential@ to mean that, without the action, the goal or objective will not be attained. Hence, superfluous actions are avoided. In practice, however, the thresholds of sufficiency and necessity are always ill-defined. Estimates of what is sufficient or essential are subjective and highly uncertain, informed as much by individual experience and intuition as by hard data and rigorous analysis. We suspect that much of the apparent disagreement about which biological alternative in the plan should be preferred reflects such individual differences in perspective.

One of the major concerns of our team regarding the planning process and the general content of the biological alternatives in the Draft Plan is that scientific information was often mixed with pragmatism and perceived political reality, without any documentation of how these two classes of knowledge were combined. We believe the credibility of the Plan would be enhanced by addressing ecological issues as objectively and scientifically as possible, free from the constraints of perceived political reality. Socioeconomic and political factors can be considered later as a Acost screen@ overlaid on planning alternatives. We address this issue in more detail in some of the responses to our assigned questions.

In cases of high uncertainty and high risk, the precautionary principle suggests that it is better to err on the side of protecting too much habitat than too little, that is, to err on the side of sufficiency rather than necessity. Of course, too great an error in either direction will condemn a plan to political, legal, or economic failure. The best way to minimize the chances of error, and hence meet the sufficiency-necessity standard, is through rigorous science. In practice, however, data, funding, and time are usually insufficient for highly rigorous scientific investigations on the scale of a regional conservation plan. This is the case here. The sufficiency-necessity problem remains, and we would like to see this problem receive more explicit attention in the MSHCP/NCCP.

The Draft Coachella Valley MSHCP/NCCP proposes three conservation design alternatives. Alternative 1 would protect only those lands already in public ownership. We can consider this alternative a null hypothesis that can be easily rejected, as it clearly falls short of meeting the requirements of law (e.g., U.S. Endangered Species Act, California Natural Communities Conservation Planning Act). The Draft Plan properly concludes that Alternative 1 does not contain sufficient natural habitats and associated resources to fulfill essential goals. Alternatives 2 and 3 encompass all lands in Alternative 1 and contain additional private lands. Alternative 3, which was developed based on recommendations from state and federal agencies, is the largest in acreage and subsumes Alternative 2. There is some difference of opinion among the public agencies and other stakeholders regarding the adequacy of Alternative 2 and the need to include some or all of the additional lands identified in Alternative 3. The possibility also exists that even Alternative 3 does not include sufficient habitat and/or other resources to sustain the covered species. Uncertainties remain concerning the minimum habitat areas for particular species, the importance of specific areas as habitat for these species, and the value of potential corridors for flow of individuals and genes and/or maintenance of critical geophysical processes, such as sand and water sources and fluvial and aeolian sand transport.

The Draft Plan should account for the need of covered species to track changes in the distributions of their habitats over time in response to climatic or other environmental changes. In this regard, it is notable that species distributions are often correlated with temperature and moisture gradients, which are likely to shift in response to climatic change. Thus, a warmer, drier climate is likely to cause species associated with higher moisture and/or cooler temperature regimes to be reduced in numbers or eliminated from existing occupied habitat lands where climatic conditions are currently marginal. Such species could become more restricted to the western portion of the plan area (Whitewater-Snow Creek-Windy Point areas). Conversely, in the event of climatic cooling, which is a probable successor to the current warming phase, species associated with warmer and drier habitats may become more restricted to the valley floor and southeastern portions of the plan area. Maintaining well-connected, heterogeneous landscapes with multiple microhabitats and potential refugia is a sensible strategy in the face of climate change in any direction (R. Noss, 2001, *Conservation Biology* 15: in press). Thus, long-term conservation planning for the Coachella Valley must consider maintenance of physical linkages over a range of existing temperature-moisture regimes and elevations. We note that the Draft Plan gives scant attention to such long-term issues.

The Plan, especially Alternative 3, maintains considerable landscape connectivity around the margins of the valley, which are mostly mountainous terrain, but much more tenuous linkage opportunities across or longitudinally through the valley. To a large extent the opportunities for such linkages are precluded by agricultural and, to a greater extent, urban land uses. Nevertheless, some opportunity exists to use the Whitewater River channel, the railroad right-of-way, and even highway rights-of-way to maintain some level of connectivity through the length of the valley. The Whitewater River in particular seems to be a good candidate for maintaining a linkage for a number of habitats. Serious discussion of this option should be included in the Plan. Of course, regulatory agencies must consider the costs and benefits of conserving particular areas relative to other potential sites in the planning area before they enter negotiations with stakeholders.

<u>Responses to Specific Questions Posed to Science Advisors</u>

The general reaction of our team to the questions provided is that many of them are questions best addressed to the planners, not to reviewers. In many cases data that would allow us, or anyone, to answer the questions are not available. The four geomorphology questions are a case in point: Answering any of these questions would require substantial new research. Nevertheless, in all cases we have provided our best answers, given the best available information. In some cases we suggest the kinds of field studies and analyses that would be necessary to answer the questions definitively.

<u>I. Habitat/Landscape Level Questions:</u>

1. Evaluate each Conservation Alternative using the attached ACriteria for Evaluating Site Identification Maps.@ (Conservation Alternatives are described on pages 90-105 of Administrative Review Draft).

Choosing among alternatives boils down to an exercise in best professional estimation. High quality data sufficient to make a defensible choice of an alternative are simply not available. This lack of data is par for the course in conservation planning. As noted earlier, we believe that in the face of poor data, the precautionary principle should hold. In all of the 11 specific areas of contention (i.e., areas of land included in Alternative 3 but not Alternative 2), and all else being equal, we can be sure that the Plan would be improved by the inclusion of additional habitat. Thus, the burden of proof should rest on showing that excluding the additional areas in Alternative 3 will not jeopardize the ability of the plan to sustain viable populations of the covered species. Because the SAC included their estimation of socioeconomic and political criteria in decisions that, at this point in the process, should have been made purely on biological/ecological grounds, we do not believe they placed the burden of proof on the correct side in developing Alternative 2. This is particularly important given that precisely how socioeconomic and political criteria influenced their decisions is not documented in the Draft Plan.

The SAC=s general approach in developing Alternative 2 was to suggest that adding extra habitat would not increase the Plan=s ability to sustain populations. They appeared to be influenced more by necessity than sufficiency. In several cases we believe the SAC overemphasized potential negative aspects of sites suggested by the agencies in Alternative 3, or at least did not provide adequate documentation for these assumed negative aspects. For example, in arguing against the inclusion of the AFlat-top Mountain and Dune Area North of I-10" (p. 106 of the Administrative Review Draft [ARD] and in comments during the February workshop), the SAC=s argument for not including the area was that the dunes were no longer active, and this, combined with the high per-acre value of property in the dunes meant that the area was not necessary for protection of the species on the proposed covered species list. The idea that the area, though sub-optimal, might serve as a buffer for the more intact areas to the north was not considered or documented explicitly, nor were potential management practices apparently considered, such as active disturbance to reactivate dunes or human-assisted movement of sand into the system. Such procedures, while expensive and intensive, might be necessary for the conservation of some species or natural communities.

In another case, Athe area between Date Palm and the extension of Duval Road@ (pg 110 ARD) Alternative 2 appears to exaggerate the potential negative effects of human structures on the conservation value of the site, or at least does not provide adequate documentation to support the conclusion that these structures eliminate the area for conservation purposes. During the workshop the SAC indicated that the primary reason they did not include this area in Alternative 2 was the presence of a road that bisects it. In the ARD the SAC also discusses the small size of the area. Aerial photographs of the site indicate that large portions of the area are not bisected by roads and that the area, while small, could sustain large populations of some of the endemic insects and plants covered in the Plan. This area may have been dismissed too quickly and the presence of a road weighed too heavily in the decision-making process. Although substantial scientific literature suggests that roads have negative effects on many taxa, making the presence of a single, two-lane road the primary reason for rejecting a site overextends the scientific evidence for negative effects of roads. Many assumed barriers are better seen as filters, as some movement of organisms occurs across them. We understand that plans to widen this road exist, but the Alternative did not consider the possibility of designing a road to include underpasses for animals.

Moreover, it is not enough to do conservation on maps. As pointed out later in our comments, especially with regard to adaptive management, the Plan must specify the ways in which mistakes or omissions in the Plan will be corrected in the future. Ideally, each conservation sub-area requires its own plan with explicit biological objectives and management approaches identified.

As suggested earlier, the documents seem to have taken a largely static view of the ecosystems of the Coachella Valley. In some cases they are perhaps too narrowly focused on the notion of a pristine, self-managing system as the only kind of habitat that should be included in a reserve. The documents appear to have given little attention to options such as maintaining habitat for the covered species via active management. The plan also does not explicitly consider the possibility that habitats disturbed by human activities may recover over time or be restored to provide suitable habitat in the future (see R. Webb et al., 1988, The effects of disturbance on desert vegetation in Death Valley National Monument, Cal. *USGS Bulletin* 1793). Recovery from soil compaction requires about 80-120 years in the Mojave Desert (R. Webb et al., 1986, *Soil Science Society of America Journal* 5):1341-1344).

The inclusion or deletion of lands proposed for conservation in Alternatives 2 and 3 must be based on sound principles of conservation biology and factual evidence or strong inference of conservation value. Because the additional lands proposed for inclusion in Alternative 3 are scattered throughout the plan area and because their proposed inclusion is based on diverse factors, each must be considered separately. We do this briefly below for several of the areas under discussion.

Expanded Snow Creek Area between Interstate 10 and California Highway 111, west of the Whitewater River.

This area is located within an important transient sand source and sand transport area and provides habitat for sand endemics such as the Coachella Valley Jerusalem cricket, Coachella Giant Sand-treader cricket, and Palm Springs pocket mouse. Although this land currently may not be crucial to the protection of these species, it offers a refugium during major flood events that could affect the adjacent Snow Creek/San Gorgonio Wash habitat area and provides a broader contact zone between that area and Whitewater Canyon. Additionally, it should be noted that many sand endemic species (including those mentioned above) are distributed primarily in the northwestern end of the Coachella Valley and are probably limited by moisture and temperature gradients. Ongoing climate change will alter the existing temperature/moisture gradient and, thus, the distribution of suitable habitats for many species. Some species already concentrated in the northwestern portion of the plan area are likely to become more confined to it, as they are eliminated from areas further east. Use of this land for wind-generated electric power might be compatible with both the conservation of covered species that persist under this form of land use and perhaps for the conservation of natural communities.

Although Alternative 2 concludes that natural ecological processes for this land have been compromised by the railroad and by Highway 111, the habitat in this area has similar value to that in the adjacent areas of Snow Creek/San Gorgonio River Wash, and Windy Point. In Greg Ballmer=s experience, the arthropods are the same and may even be more abundant in the proposed expansion area of Alternative 3. Highway 111 and the railroad are not absolute barriers to movement of either the sand-inhabiting arthropods or the sand in this area.

This triangular-shaped parcel, bounded by major highways to the north and south and the Whitewater River to the east, could be a major refugia for animals dependent on local aeolian systems. The San Gorgonio River is isolated from this parcel owing to the barrier formed by California 111, and the Whitewater River is channelized as it passes north to south along its east end. Small, relatively active areas of sand exist in this parcel, suggesting that it might be marginal habitat for sand-preferring organisms covered under the MSHCP. In addition, several species have known distributions in this area, which is relatively pristine in comparison to similar areas towards the northeast. The assumption that the natural ecological processes for this parcel have been compromised is not entirely correct, but public agencies are regularly bulldozing the Whitewater River channel in this area with the apparent goal of eliminating riparian vegetation that uses Colorado River aqueduct water destined for the recharge galleries downstream. Because this practice effectively eliminates cover that might provide a wildlife-migration corridor, the MSHCP should explicitly suggest that the practice be eliminated. If it is eliminated, the value of the triangular parcel would be greatly increased.

Expanded Mission Creek Area

This area may provide low-density habitat for a few vertebrate species, such as desert tortoise. Its inclusion in the reserve system would also provide a more defensible perimeter and buffer for the adjacent Mission Creek conservation area. It would be useful to have more information on the biological resources of this expansion area and an analysis of potential damage to the Mission Creek area if it were urbanized or converted to other uses. Additionally, it should be noted that a recent finding of the Coachella Valley Jerusalem cricket in a patch of aeolian sand atop the bluffs on the north side of Whitewater Canyon (wind farm area) indicates that this species is somewhat more widespread than previously thought and may occur in the expanded Mission Creek area. Further surveys for this species are probably warranted in this area.

One of the major rationales for including this expansion in Alternative 3 is the belief from previous reports that the area provides a significant source of fluvial sand that could be entrained and moved downstream to the aeolian source area. This belief is incorrect; most of the sand supply transported in Mission and Morongo Creeks comes from areas upslope from this parcel, which mostly serves as a zone of transport from mountain front to depositional area. Channelization of Mission Creek in this area could improve sand delivery from the sources in the San Bernardino Mountains to the depositional area south of the Banning fault by improving hydraulic conveyance across the alluvial fan (which is built from sedimentation from Mission Creek and Morongo Wash) to the depositional plain west of Willow Hole and minimize within-channel storage of sand that is unavailable for aeolian transport.

Expanded Whitewater Preserve Area

The water recharge basins along the Whitewater River south of I-10 and north of Highway 111 are in the middle of a potential sand transport area. However, the configuration of the basins greatly impedes sand transportCdunes are present on the downwind sides of the basins and are effectively trapped until released by dredging. The river floodway is routed around the basins and, thus, does not interdict much of the sediment flow. It may become possible to reorient the basins at some time in the future to increase the rate of aeolian sand transport, while also reducing basin maintenance costs. As the basins are designed to wash out in a major flood event, there seems to be no urgency in altering their orientation at this time. It would be appropriate to discuss such matters with the water district staff to determine the feasibility of future alterations.

Also, the presence of the basins serves as a wind shadow for significant areas downwind of the basins but upwind of the Preserve that could be viable habitat for several species covered under the MSHCP. The presence of wind generators on this land, plus its prime location as depositional area for Whitewater River, plus the potential for aeolian transport across it makes it a prime candidate for restoration. One potential means would be to alter the configuration of the main northern dike that protects the recharge galleries from the Whitewater River at flood stage by shortening it (not adding dredged material as is done currently). This would allow large floods to spread out sooner, dropping their sand loads upwind from the Whitewater Preserve instead of enhancing the probability that floodwaters will pass down river toward Palm Springs.

Expanded Willow Hole and Sand Source Area and Flat-top Mountain and dune area north of I-10
Alternative 2 envisions protection of a relatively narrow pair of active stream channels (Mission Creek and Morongo Wash) east of Highway 62 to maintain sediment transport to the valley floor where it can be redistributed by aeolian processes to feed the active dunes in the Willow Hole area. Expanded protection of this area, as proposed in Alternative 3, may increase protected habitat for a few vertebrate species and improve the value of this corridor for animal movement over a range of elevations. More data is needed to determine the real value of this area to the Palm Springs pocket mouse and other species, which may use it as core habitat or as a movement corridor.

Expansion of this conservation area could potentially give greater protection from potential future flood control alterations. Observations in late February, after the February 12-13 storm, indicates that much of the depositional area for Mission and Morongo Creeks north of I-10 is inundated even during relatively light runoff events. Channelization of this area would be devastating to the Willow Hole sand-delivery system.

On the other hand, Mission Creek is already channelized between the San Andreas (Banning) fault and about California 62. It performs the desired function: it delivers sand with minimal storage on the alluvial fan west of Desert Hot Springs. Morongo Wash, however, is not channelized and does store sediment in that same area. The channelization of Mission Creek also retains sand from being lost owing to aeolian activity, while the unchannelized Morongo Creek is losing sand, which is stored in aeolian dunes east of its channel. (This, of course, suggests management just east of Morongo Wash for species dependent on aeolian habitat.) Channelization is beneficial in certain circumstances related strictly to fluvial sand delivery systems. Most floods already are caused by rainfall (the most severe rain on snow), so climatic changeCunless it shifts storms from winter to summerCmay not be a major issue for this area. We expect such floods to cause degradation in the channels upslope, which means more sand is moved into the depositional plain that is the target of the MSHCP. What is most needed is a ban on channelization south of the San Andreas (Banning) fault, either north or south of I-10 and the railroad. Deposition south of I-10 benefits the Whitewater River Preserve, so this is a case where preservation of the entire system greatly benefits the aeolian-dependent species.

In addition, recent field work of Robert Webb and colleagues suggests a more direct source for aeolian sand to Willow Hole than Mission/Morongo. There are several canyons in the Little San Bernardino Mountains due north of Willow HoleCLong Canyon, West End Canyon, and East End CanyonCas well as a drainage in the Indio Hills due east of Willow Hole that appear to be potential major contributors of fluvial sand. West End and East End Canyons are blocked by a long dike system that effectively stores all sediment at the mountain front while releasing water through a long, mostly underground culvert that flows to the southwest and away from Willow Hole. Active management of undeveloped parts of the Seven Palms Valley, particularly related to channelization of distributary flow channels from Long Canyon, could be helpful to the Willow Hole sand-delivery system while allowing development upslope.

Big dune South of I-10
The major controversy for this site seems to be economic cost versus biological benefit. It may very well be too costly in terms of money and/or political capital to protect. Nevertheless, the biological value of this site should determine whether to include it within the scope of the conservation program in the Draft Plan. Much of the rationale for excluding it seems to be a presumption that it is a Adead@ dune, cut off from the sand source that is needed to maintain it as an active dune. However, some of the covered species do quite well in stabilized dunes and may inhabit the Big Dune. Further survey work is needed to determine if it is an important site for Coachella Valley Jerusalem cricket, for example. This area is very near the easternmost record for this species (adjacent to I-10 at the Thousand Palms off-ramp. See also our response to Question #1, Species Level, All Species.

East End of the Indio hills
The dunes in this area are well separated from others to the west, and land use changes have all but eliminated sandy habitat connections between them. The formerly robust sand delivery system from the Whitewater River - Mission Creek - Morongo Wash has been completely truncated, leaving only sand sources in the Indio Hills and the Little San Bernardino Mountains. The biotic community of the eastern dunes is somewhat different from those of dunes further west; this difference provides an argument for their inclusion in the Draft Plan in order to cover all habitat types and natural communities. It seems that there is not enough survey information currently to determine the value of this area for a number of covered species that may use it. Again, it is worth mentioning that climate change may result in the geographic range of this community type, or at least of some of its components, either expanding or contracting in the future. Under a warmer, drier climate this community is likely to expand or shift to the west; while a cooler, moister climate could result in its displacement by other species, which currently have a more western distribution within the valley (if landscape linkages are maintained). The isolation of this area from other dunes argues against its value in contributing in a major way to genetic or demographic interchange with populations elsewhere. However, given the abundance of dune endemics (especially plants and insects) throughout the Southwest, one cannot dismiss the possibility that a number of species could survive and maintain their evolutionary potential even if this dune area becomes increasingly isolated.

Conclusion:
In considering how to distribute conservation areas in the Coachella Valley, two opposing considerations should be kept in mind: 1) the need to distribute reserves throughout the planning area in order to provide for multiple populations (redundancy) of the covered species and to represent communities across their natural range of variation; and 2) the need to concentrate

conservation areas in portions of the Valley that are biologically richest (i.e., hot spots) or where habitat quality if highest and persistence of populations over time is most probable. These two considerations need to be balanced in the Plan. The argument for concentrating reserves in the western portion of the planning area, where precipitation is higher and population densities of covered species are generally higher, is attractive, and makes even more sense in the context of global warming. Nevertheless, such a strategy could be counterproductive if it results in loss of population redundancy and reduced representation of natural communities across the Valley. Moreover, a reserve system concentrated in any one portion of the Valley would be more vulnerable to Acontagious catastrophes@ (i.e., disease, extreme weather episodes, geomorphic change) and other synchronized environmental events that could extinguish local populations.

Alternative 1 does not provide for the sand delivery systems that affect major habitat in the northern Coachella Valley. Alternative 2, while much better, relies too heavily on terrain and climatic features (e.g., windy area won=t be developed into housing units) to preserve the integrity of the sand delivery systems. Alternative 3 may go too far in some areas by assuming that significant sand is generated on alluvial fans instead of upslope in the San Bernardino and Little San Bernardino Mountains and the Indio Hills.

We have not undertaken a thorough analysis of the potential effects of the three planning alternatives on covered species and natural communities, which we believe is outside the scope of a peer review. This topic is reasonably well covered in the Draft Plan, given the limitations of available data. In any case, these limitations prevent us from saying much more about the potential population viability of any of these species under the Plan alternatives. Some notes on the covered invertebrate species, prepared by Greg Ballmer, are in Appendix 1.. In addition, the team botanist and restoration ecologist, Edith Allen, provides some comments on the plant species and natural communities:

Overall, Alternative 1 is unacceptable for two of the five plant species, but Alternative 2 is acceptable for all five, with reasoning as follows:

Alternative 1 is clearly unacceptable for the Little San Bernardino Mountains gilia, which has only three known locations that lie in lands protected by Alternative 1. Only 18% of the modeled habitat for the Coachella Valley milkvetch lies in Alternative 1 protected lands. Of the five plant species, only the triple ribbed milkvetch would be unaffected if Alternative 1 is chosen.

The difference between Alternatives 2 and 3 is relatively small or not different for LSBM gilia, triple-ribbed milkvetch, and Orocopia sage. The Mecca aster would lose about 20% of its habitat if Alternative 2 is chosen, which is probably not a threat to its existence. The C.V. milkvetch is the most extensive of the five plant species, and will lose the most acreage if alternative 2 rather than 3 is chosen. However, protection under Alternative 2 will probably not threaten its persistence. Of the 5 plant species, the C.V. milkvetch is the only one known to occur on the Big Dune. The C.V. milkvetch occurs on stabilized as well as active dunes, and would likely survive on Big Dune even though the geomorphic processes of dune building are no longer active. The other four species are in river washes, dry fans, creosote scrub, and other communities, but are not sand-obligate species.

Eleven of the 26 natural communities have only about 1300 acres or less in the planning area. Alternative 1 gives insufficient protection to at least 8 of the natural communities (under a 50% protection criterion for the communities of limited area). At least seven of these small communities are wetland ecosystems that should be conserved as much as possible because of the critical habitat they provide for target and non-target species. Losing wetlands and springs would obviously endanger additional species not currently covered. Under Alternative 2 all these small community types would achieve up to 98% protection, except for mesquite hummocks. Mesquite hummocks would be protected up to 50% under Alternative 3.

Two larger community types deserving special protection are the active sand fields that provide sand for other sites as well as habitat for sand-requiring species, and the dry wash woodlands that are habitat for many target species. The active sand receives 75% and 93% protection under Alternatives 2 and 3, respectively, but deserves as much protection as possible to preserve other sand-dependent habitats downwind. The dry wash woodland is quite extensive (some 40,000 acres) but is important habitat for desert tortoise, bighorn sheep, several target bird species, other migratory birds, and is the only habitat for the LSBM gilia. Preservation of dry wash woodland on the northeast Salton Sea (under Alternative 3) may be important for animal movement. Some of this woodland has been converted to exotic tamarisk, but would still be valuable habitat and corridor if restored.

In summary, we offer the following brief responses to the Acriteria for evaluating site identification maps@ as a way of comparing alternatives 1,2, and 3, emphasizing that such a comparison is more appropriately made by the planners (i.e., the SAC) than by reviewers.

1. Are the habitat patches within the sites large enough to sustain the species/natural community? It is important to recognize that patch size cannot be considered independently from patch configuration; these qualities interact to influence population viability. Two or more small patches within dispersal distance and not separated by movement barriers may be treated as one larger patch by a species. This question is also highly species-specific. As we have noted, data are generally insufficient to answer this question, and no PVAs have been conducted. Nevertheless, Alternative 1 seems to be insufficient for many species. Alternative 2 would provide patches large enough for many or most of the covered invertebrates and plants, barring major environmental change. The larger, better connected patches in Alternative 3 would offer higher probabilities of persistence for most species, but especially the vertebrates.

2. How many of the existing sites where the species or natural community occurs in the Plan area would be protected under this Site Identification Alternative? Is this considered to be sufficient by biologists with expertise on this species or natural community? Please refer to our discussion above. This is not really an appropriate question for reviewers.

3. Are connections to other sites essential? If so, do meaningful connections exist, and can they be maintained? For many or most covered species, and speaking generally, we can say with confidence that connections to other sites are essential, especially in the long term and considering the inevitability of environmental change. Some meaningful connections certainly exist, but exactly how meaningful needs to be determined by research. Alternative 3 provides more connectivity than Alternative 2. Whether that additional connectivity is essential has yet to be established, but the precautionary principle suggests maintaining existing connections where possible, until the necessary research has been conducted. As noted elsewhere, connectivity across highways and other potential barriers could be improved through engineering approaches.

4. Is the site large enough to sustain any keystone species, such as large predators necessary to maintain essential ecological processes? There is insufficient attention to large predators (e.g., mountain lion, bobcat, coyote) in the Plan. These are not considered covered species, for good reason, but could serve as focal species for designing the reserve network. For these species, no single site is large enough to sustain a population, so connectivity is the key issue.

5. Are the sites representative of the range of environmental conditions...under which the species or natural community occurs in a viable population? Insufficient data are provided to answer this question. As discussed above, a network of conservation areas well distributed across the Valley would be preferred for this purpose over a design concentrated in one portion of the Valley.

6. Can necessary physical and ecological processes be maintained? This question is highly site-specific, and is addressed elsewhere (to the extent possible, given data limitations) in this report.

7. Is there a significant potential for adverse edge effects from adjacent land uses? Could these be so severe as to jeopardize the viability of the site? Could these edge effects be successfully managed? Edge effects are virtually unstudied in the Valley. Research elsewhere suggests that edge effects could be pervasive, but are manageable to some extent by such means as constructing Ahard edges@ (e.g., fences impermeable to opportunistic predators such as house cats and raccoons) around small isolated reserves, managing invasive species, and maximizing reserve size generally. In addition to the probability of biological edge effects, aeolian areas have strong edge effects related to stability and mobility of sand sheets. In effect, this is a natural edge effect comparable to that of habitat fragmentation. Because of this, we believe it is better to err on the side of too much conservation than too little when it comes to the aeolian-dependent species.

8. Is there a significant potential for impacts from deleterious activities on the site, such as illegal dumping, off road vehicle activity, shooting, or illegal collecting? Could these be so severe as to jeopardize the viability of the site? Could these edge effects be successfully managed?

As in our response to question #7 (above), these kinds of edge effects are probable. Although they have not been studied in the Valley, efforts to reduce their potential impacts should be taken.

9. Is there a potential for exotic species to adversely impact the site? Could these be so severe as to jeopardize the viability of the site? Could these edge effects be successfully managed?

Same response as above.

2. Did the site identification process and development of conservation areas follow a systematic, stepwise process, including the appropriate use of species models?

Of fundamental concern in any conservation plan is whether the process of identifying sites and designing conservation areas was systematic and rigorous. Chris Margules and Bob Pressey (2000, *Nature* 405:243-253) note that systematic conservation planning is highly superior to opportunistic or politically-biased planning and has several key attributes: 1) it requires clear choices about the features to be used as surrogates for overall biodiversity, 2) it is based on explicit goals, preferably translated into quantitative, operational targets, 3) it recognizes the extent to which conservation goals have been met in existing reserves, 4) it uses simple, explicit methods for locating and designing new reserves to complement existing ones in achieving goals, 5) it applies explicit criteria for implementing conservation action on the ground, and 6) it adopts explicit objectives and mechanisms for maintaining the conditions within reserves that are required to foster the persistence of key natural features, together with an effective monitoring and adaptive management program.

The approach taken in development of the conservation alternatives meets most of the criteria of systematic conservation planning in a general sense. For example, clear choices were made about the species and communities to be used as surrogates; the conservation goals are reasonably explicit; the limitations of the current reserve network are recognized; and the methods and site selection criteria are fairly explicit. We are concerned, however, that modern, quantitative tools were not employed to accomplish the required tasks. Hence, the process of site selection was more subjective and less transparent than it would have been if more rigorous methods had been applied. For example, there was no use of sophisticated habitat suitability models, PVAs, or site selection algorithms (e.g., SITES, a program developed by The Nature Conservancy for ecoregional conservation planning; S. Andelman et al., 1999. *SITES V 1.0: an analytical toolbox for designing ecoregional conservation portfolios*, The Nature Conservancy). Rather, selection of sites was based on GIS overlays and expert opinion. The failure to apply rigorous models reflects, in large part, the paucity of data on the species and communities concerned. Nevertheless, we feel that a more technically rigorous and sophisticated site evaluation process could have been applied and would result in a more defensible Plan. (See our response to question #6 in this section, below, and response to question #4 under Species Modeling.)

The site-identification process involved both scientific and non-scientific analyses. The scientific analyses are reasonably well documented for most species, but the non-scientific analyses, which involve issues such as monetary value of property as an inhibition to purchase, and prior land-use history, are not well documented. These two analyses need to be clearly separated, and the separation could explain, in part, the reason for the differences between Alternatives 2 and 3 and make the choice between the two B or, alternatively, a hybrid of the two B more objective.

The justification for the site-identification process appears in the ARD (p. 65-67). It is somewhat unusual that this plan uses GIS analysis with definite equations between data layers, yet no equations are presented in the documentation and the descriptions are somewhat vague. For example, multipliers are discussed but the final values are not given or referenced in the text. The ARelative Conservation Value@ ranges from 0-25, yet there is no conversion equation given to combine ACovered Species Richness@ (number of target species, ranges 0-31); ACovered Natural Communities Richness@ (number of natural communities, possible range of 1-46 but probably never greater than 2-5); AHabitat Heterogeneity@ (number of natural communities plus landform types, possible range given as 1 to >10); and AHabitat Fragmentation@ (explicitly defined, 0-100%). It would appear that ACovered Species Richness@ is double weighted, the combination of ACovered Natural Communities Richness@ and AHabitat Heterogeneity@ represents a double weight, and AHabitat Fragmentation@ is a single weight, but it would be valuable to see this in equation form, for example:

RCV = f5*(2*f1*CSR + (f2*CNCR+f3*HH) + f4*HF)

where the f=s are conversion factors to obtain the units of RCV. This would help the scientific credibility of the document as well as provide the more technically inclined audience to understand the basis for the plan.

The species models appear to be derived from considerable information, both in terms of mapped habitat information in GIS formats and the long experience and personal observations of the members of the SAC. As noted in the ARD (p. 64), species such as the ones covered in this MSHCP are difficult to map because of highly specific habitat requirements (which map require map units far larger in scale than the quarter section analysis used in the ARD) or the habitat requirements may only be vaguely known.

Most of the maps depicting current and/or historical distributions of species and the corresponding habitat model appear to be consistent and credible. For some species, like the desert slender salamander, the ARD leaves absolutely no doubt what is required for management of the species. However, some of the credibility of the ARD is damaged by seemingly incongruous information presented in map form or omissions from the documentation. For the Coachella Valley fringe-toed lizard, all the documentation is presented in the 1985 HCP and none of the information is repeated, even in summary form in the Technical Appendix. This needs to be corrected by providing a good summary that references the previous work. The only real information on this species appears on the map depicting the species distribution model, and this has semantics problems that beg explicit documentation in the ARD or the Technical Appendix. For example, distributions pre- and post-1979 appear to be issues on this mapCwhy? If pre-1979 distributions are irrelevant, as appears to be implied by the APotential Distribution@ model, then why are they included? Should APotential Distribution@ be renamed APotential Distribution, Post-1979@? How is it that some AKnown Locations, Post-1979@ fall outside the potential distribution? These issues need to be dealt with on the map and in the documentation.

Other maps appear to be contradictory, although that appearance may arise solely from inadequate documentation or insufficient labels on the maps. For example, for the Yuma Clapper Rail, at least three AKnown Locations@ are outside of the APotential Distribution,@ which would raise questions about the validity of the potential distribution and the expert opinion model on which it is based. It is possible that those dots hide mapped potential distribution and therefore cannot be seen at the scale of this map, but that should be explained in the caption. For certain speciesCparticularly the Coachella giant sand treader cricket, the Palm Springs pocket mouse, the Coachella Valley milk vetch, the Crissal thrasher, the Palm Springs ground squirrel, the flat-tailed horned lizard, and the Mecca aster -- significant differences are depicted between AKnown Locations,@ APotential Distribution,@ and ACore Habitat.@ How can a known location be outside a potential distribution? If this isn=t simply a semantics problem, this needs to be explained in detail or the credibility of the species model is seriously jeopardized. How is it that in many cases (see Palm Springs pocket mouse) the number of AKnown Locations@ is much higher outside of the ACore Habitat@ than inside? Does the ACore Habitat@ imply that points are not depicted within its boundaries because of the number of observations? Some of these maps show known locations in urban areasCdoes this mean that these species can adapt to urban environments and do not require specific areas to be set aside for special habitat management? For many bird species, the potential migratory areas and potential breeding areas are different from the observed locations of the species, in some cases with little or no overlap, and this appears to be a problem. Some species do not have potential distribution models, and, although this is discussed in the Technical Appendix, it should be noted on the map caption.

As these questions might indicate, the maps leave open alternative interpretations which may undermine the credibility of the MSHCP. For example, one might interpret the depictions of some core habitats as extremely conservative to the point of potential jeopardy for the species being managed, and therefore criticize the plan as insufficient to protect that species. Alternatively, given certain species= occurrence in highly urbanized areas, one might question the need for management of those species by setting aside lands or limiting development when they appear to tolerate existing developments. The point is that the species models appear to require much more documentation, particularly on the maps and their captions since they are separated from the Technical Appendix. Our general conclusion is that the species models are probably adequate but their documentation falls short. This shortfall affects the perceived credibility of the plan in general and must be rectified.

Certain non-scientific issues appear to be presented as scientific issues, such as habitat fragmentation (ARD, p. 66). However, data on fragmentation are never presented in map form to allow the readers to evaluate for themselves the amount of fragmentation that exists on areas adjacent to alternative 2 areas, or whether alternative 2 areas themselves are already fragmented. Also, certain species may not be affected by habitat fragmentation as depicted in the ARD, and this interaction may be desirable as a way of differentiating habitats as favorable for some species but unfavorable for others. As discussed during our February 12 meeting, land valuation had a major influence on exclusion of certain potential habitats from alternative 2. We believe that some form of land valuation should be depicted in map form for the ARD if this alternative is to be included.

3. Is thorough documentation provided for the methodology and the data used to identify core habitat areas?

Regarding documentation, please refer to our response to the previous, related question (#2). For many species, core-habitat areas are not depicted and the reasons appear to be documented in the Technical Appendix. In general, no documentation of core-habitat delineation for species in general is presented either in the ARD or the Technical Appendix. As noted under question 2, the documentation for certain species models with core-habitat areas is inadequate as presented in map form, which is the only way it is shown in the documentation we were given. In many cases, the documentation for the methodology and the data used to identify core-habitat areas are sufficient even in the absence of an overall description of how core areas were delineated, particularly for a number of bird species. In some very noteworthy cases (*e.g.*, the Coachella Valley fringe-toed lizard), the methodology and data used are nearly all contained in an old (1985) habitat conservation plan which may be unavailable to someone reviewing this document. A summary of this HCP needs to be provided.

Because of the lack of an explicit scientific discussion of delineation of core-habitat areas, one is left to speculate as to how these areas were delineated. That such speculation is possible, of course, undermines somewhat the scientific credibility of the MSHCP. One possibility that explains the discrepancy between mapped core habitat and known distributions is that a political filter, such as cost of land acquisition or known opposition from developers or land owners, may have been overlain on the known distribution. The core-habitat areas for some species appear to broadly follow the outlines of known distributions of aeolian sand, particularly given historical development patterns, and if so, this should be simply stated. As this discussion indicates, thorough documentation has not been provided concerning the delineation of core-habitat areas and this problem needs to be rectified.

6. What are the limitations in the site identification process?

A significant limitation is that the methods (see pages 64-70 of the ARD) fail to recognize that the 31 focal species have very different spatial and temporal scales at which their population dynamics play out across the planning area. As such, the ranking criteria used may be inappropriate for some of the larger species. For many of the 31 species (those where population dynamics play out a smaller spatial scales), the methods described may be appropriate because many, if not all of the factors driving viability in the planning area will be driven by local processes that determine births and deaths within habitats. However, for larger bodied species, whose population dynamics occur at larger spatial scales, the spatial patterns of how reserves are configured, the size of the core areas, and the pattern and effectiveness of linkages between these cores become critical to maintaining viable populations. Thus, for these species, the issue of reserve design becomes one of dealing with dispersal and other demographic processes within and between core areas. The methods described on pages 64-67 demonstrate little awareness of the importance of patch size and configuration on viability for such species.

Another major limitation is the discrepancy between mapped points of AKnown Distribution@ versus the APotential Distribution@ outlines derived from GIS analysis. Either 1) very few observations have been made on many of these species, lowering the information content needed to depict potential distribution, or 2) not all known distribution points are included on the maps. As discussed in the Technical Appendix, some of these species have highly specific habitat preferences that are difficult to plot at the 1/4 section level in map form, much less at the scale given on the oversize map sheets.

Furthermore, there does not appear to be much if any discussion on adaptive plasticity, where species may adapt to different habitat conditions if ones they previously occupied are degraded. In the case of the Coachella Valley fringe-toed lizard, there was some discussion that as active sand area decreased in natural habitats, the lizards may have switched to habitats created artificially by berms and a landfill. Other species appear to have adapted already to urban environments; we suggest the documents should discuss the implications of this potential adaptation. The site-identification process is in some ways hindered by the assumption that conditions at the time of the plan are representative of the full adaptation of the species without consideration of the potential full range in habitat variability.

We are also concerned that the Asite identification mapping@ methodology (section 3.6.1, pp. 65-67 of the ARD) is inadequate for conservation of natural communities. Because the Plan is also a NCCP, not just a MSHCP, adequate representation and conservation measures for natural communities are essential. As noted on p. 89 of the ARD, natural communities are considered in the Plan only in terms of providing habitat for covered species. This purpose is obviously redundant with the accompanying goal of protecting habitat of covered species. Instead, natural community conservation might be seen as a coarse filter that complements the fine filter of species conservation. The coarse filter is predicted to capture species about which little is known (e.g., poorly surveyed taxa such as many invertebrates, fungi, bryophytes, and bacteria) and serves to protect a higher level of biological organizationCthe community or ecosystemCwhich may be considered valuable in its own right.

The selection algorithm also may have been applied at an inappropriate spatial scale. Applying this simplistic algorithm to quarter-sections selects for a fine-grained, as opposed to coarse-grained, environment. High beta diversity (turnover of species along gradients, as reflected in Acovered species richness,@ Acovered natural community richness,@ and Ahabitat heterogeneity@) is selected at the expense of larger, potentially more intact, blocks of particular habitats or communities. Considerable redundancy exists in these criteria, particularly between natural community richness and habitat heterogeneity. It would have been preferable to set separate targets for representation of viable occurrences of each covered species and natural community, rather than using simple richness criteria.

We suggest the planners refer to The Nature Conservancy=s ecoregional planning materials (e.g., C. Groves et al., 2000, *Designing a Geography of Hope: A Practitioner=s Guide to Ecoregional Conservation Planning*, 2nd ed.) and consider using more sophisticated selection algorithms (e.g., SITES, cited above), which would provide more quantifiable results than the methodology represented in the Draft Plan. SITES has been used as an aid for designing and analyzing alternative portfolios in a number of TNC ecoregional plans, including the Northern Gulf of Mexico, Cook Inlet, Klamath Mountains, Sierra Nevada, Middle Rocky Mountains-Blue Mountains, Utah-Wyoming Rocky Mountains, and Southern Rocky Mountains ecoregions. SITES utilizes an algorithm called Asimulated annealing with iterative improvement@ as a heuristic method for efficiently selecting regionally representative sets of areas for biodiversity conservation. It is not guaranteed to find Athe best@ solution. Nevertheless, the algorithm attempts to minimize conservation Acost@ while maximizing attainment of conservation goals in a compact set of sites. It has been used effectively in study areas with poorer data availability than the Coachella Valley.

4. Have information gaps been identified and does each alternative adequately consider uncertainty in the design of the conservation areas?

When three of us (Noss, Soulé, and Tracy) were empaneled as early reviewers five years ago, we suggested that alternative reserve designs be set up as a hierarchy along a gradient of ignorance. Specifically, it can be argued that the highest probability of success in conserving the species in Coachella Valley is to protect all historic habitat, and the advisors recommended presentation of many alternative reserve designs including that mentioned above without regard to the difficulty of implementation. Thus, the designs would be considered on their biological basis alone at first, then later within a socio-political context (i.e., a cost screen would be applied to plan alternatives).

Even a reserve design based upon all historic habitat provides no certainty of success in preserving the covered species. This is especially the case because habitat is only one element necessary to protect species from extinctions. For example, noxious exotic species are now considered the second most important threat to species worldwide, next to loss of habitat. Thus, protection of habitat needs to be put into a context of the needs to manage species vis-a-vis manifold needs within the protected habitats.

The drafters of the MSHCP reserve design have, in some cases, not considered the uncertainties of identified stressors to the covered species. Moreover, as discussed earlier, it appears that financial and political implementation impediments were folded into the conservation program in addition to biological requirements. This means that the biological needs of species may have been considered by the SAC only through the filter of their personal understanding of implementation constraints which have not been addressed explicitly in the document. As noted earlier, we detect an implicit concern with the necessity requirement that threatens to overwhelm the sufficiency requirement. This became particularly obvious in the presentations to our team as the concepts of new viaducts (e.g., underpasses for wildlife) were discussed as a means to mitigate the negative effects of roads as barriers. Members of the SAC expressed doubt that such mitigation was possible, hence their preference for Alternative 2, which considered habitat areas separated by major roads as essentially permanently isolated. A more precautionary approach would have left open options for restoring lost connectivity. This in fact may become a viable alternative if other habitat areas are lost due to political or economic factors.

An important principle in developing reserve designs is to admit ignorance of biological properties and processes and consider the consequence of that ignorance as alternative designs are proposed. Our assessment based on the documentation and discussions is that ignorance and uncertainty have not been considered explicitly in the comparison of any of the alternative designs.

5. Are adequate buffers provided for conservation, assuming full build-out under each jurisdiction=s general plan?

There are no buffer zones *per se* or other transitional areas around reserves identified in the design alternatives. Any buffer function is implicitly assumed to be provided by the outer zone of each reserve. Given the well-documented problem of edge effects (physical, biological, human, etc.), we believe the buffer zone issue should be addressed in the final plan. Evidence from several studies suggests that agricultural or low-density residential development around reserves results in less severe edge effects (e.g., nest predation on birds) than when reserves are surrounded by high-density residential development. This is probably due to higher densities of house cats and opportunistic mesopredators, such as raccoons and opossums, subsidized by garbage and pet food, in high-density residential areas (D. Wilcove, 1985, *Ecology* 66:1211-1214; L. Friesen et al., 1995, *Conservation Biology* 9:1408-1414; R. Blair, 1996, *Ecological Applications* 6:506-519). On the other hand, buffers sometimes can be population sinks, potentially draining a source population in a reserve (R. Noss and A. Cooperrider, 1994, *Saving Nature=s Legacy*, Island Press). In such cases it may be preferable to surround a reserve with a Ahard edge,@ such as a tall fence, impervious to mesopredators (M. Groom et al., 1999, Pages 171-197 in M. Soulé and J. Terborgh, eds., *Continental Conservation*, Island Press). We suggest hard edges may be most appropriate for isolated reserves, where the potential for restoring connectivity for native species is low but the probability of severe edge effect is high.

6. What are the limitations in the site identification process?

See above (grouped with #2 and #3)

7. Are sufficient data provided to determine the effects of roads on population viability for target *species?*

Roads, especially major ones, are assumed in the Draft Plan to represent strong fragmenting factors. A habitat fragmentation value was assigned to each mapping unit based on the extent of fragmentation by roads, with roads divided into three categories of width and each road Abuffered@ to include an additional area one-half the width of the road on each side. Habitat areas separated by major roads are generally assumed to be functionally isolated from one another (although, paradoxically, some of the corridors proposed in the Plan alternatives cross several major roads). We agree that many studies support the assumption that roads are major threats to biodiversity. Potential effects of roads include barriers to movement of organisms and sand, sources of direct mortality (roadkill), access to disruptive human activities (e.g., poaching, collecting, ORV use), and spread of invasive exotic species.

No data are provided, however, on the effects roads may have on the covered species and natural communities in the Plan area. Apparently no studies have been conducted. Nor are potential mitigation measures (e.g., road closures, tunnels, overpasses, fences) considered in any detail. We recommend that the adaptive management and monitoring plan include research on the effects of roads. Moreover, we recommend that specific mitigation measures to reduce the likely impacts of roads be considered in the planning alternatives.

8. Can the target species be grouped into categories that reflect general area requirements related to viability? What are those categories and general area requirements?

The ability to group species into Aconservation guilds@ should be taken as a testable hypothesis to be considered as part of the monitoring and adaptive management program. Possible answers to the first question posed above are Ayes,@ Ayes, under certain circumstances,@ or even Ano.@ However, it is likely that some lumping of species into conservation guilds is possible. This question needs to be investigated as one of the first implementation programs of the HCP insofar as it could make considerably more efficacious the management prescriptions in preserved habitat. It certainly seems that the sand-dependent species may have needs in common allowing some lumping, but this should be taken as an hypothesis. Whether area requirements alone would serve as a basis for grouping species into categories is questionable. A more fruitful approach may be one suggested by R. Lambeck (1997, *Conservation Biology* 11: 849-856), which is to group species into vulnerability guilds (e.g., area-limited, dispersal-limited, resource-limited, process-limited) and then identify the species in each guild that is most demanding. These species would then serve as potential umbrella species for the others in their guild. This process would need to be repeated for each major habitat type in the planning area, as well as for the area as a whole.

Asking Awhat are the are the categories and what are the general area requirements?@ is outside of the scope of a peer review. As reviewers, we suggest that planners make an attempt to lump species based upon hypothesized common needs and vulnerabilities. Outside reviewers could review the evidence for lumping, but the process of testing the efficacy of lumping should be proposed as an activity in the adaptive management program of the HCP.

9. Does the prescribed CVWD groundwater management plan provide adequate water table levels to sustain the target natural communities and species? If not, what additional data are needed?

Several natural communities that affect the species covered under the MSHCP are strongly affected by groundwater levels: mesquite hummocks, Sonoran cottonwood-willow riparian forest, southern arroyo willow riparian forest, southern sycamore-alder riparian woodland, mesquite bosque, and coastal and valley freshwater marsh. Of these, the freshwater marsh is probably most strongly affected by agricultural drainage, wastewater effluent, and urban runoff; those ecosystems used by bird species adjacent to the head of the Salton Sea are more affected by its water levels than groundwater; and the Sonoran cottonwood-willow riparian forest, southern arroyo willow riparian forest, southern sycamore-alder riparian woodland, and mesquite bosque appear to be mostly out of the area of active groundwater management. Therefore, the natural community type most affected by groundwater withdrawals are mesquite hummocks.

The CVWD water management plan calls for a preferred Alternative 4, which differentially affects the AUpper Valley@ from the ALower Valley@ (division line at approximately perpendicular to the valley at La Quinta). The distinction between the two areas is that the Upper Valley is mainly a tourism based economy with water used for urban environments, domestic and resort usage, and golf courses, whereas the Lower Valley is heavily dominated by agricultural usage. Alternative 4 calls for elimination of groundwater overdraft throughout the basin by importing and recharging water from the Colorado River, eliminating the decline in groundwater levels in the Upper Valley, increasing groundwater levels in the Lower Valley, and promoting water conservation. All the alternatives are compared using a groundwater flow model that excludes the Desert Hot Springs area, which is one of the key areas with respect to the MSHCP.

Mesquite hummocks are found in two distinct places with regards to groundwater: on or near active faults, such as the San Andreas, and scattered among stabilized dunes on the valley floor. The former habitat is not directly addressed by the CVWD plan and may be the most threatened of the two types owing to pumpage for the rapidly enlarging cities of Desert Hot Springs, Cathedral City, and Indio. Alternative 4 calls for eliminating the decline in groundwater in the Upper Valley, which would include most of the mesquite hummock habitat along the faults, but the modeling may be insufficient to consider flow upslope from the faults. Despite urbanization upslope from the faults at Desert Hot Springs, the flow model doesn=t cover this part of the aquifer and therefore the possibility exists that the flow system feeding the mesquite hummocks in Willow Hole may be neglected in the planning process.

Alternative 4 as stated will likely positively affect the remaining mesquite hummocks scattered around the floor of the Coachella Valley in the Lower Valley. Although groundwater overdraft has been extensive, restoration of groundwater levels (as stated in the preferred alternative) could save these unique habitats and possibly aid many of the target species in the MSHCP.

We suggest that monitoring wells be installed at selected areas in the preserves, ACECs, and other areas with significant riparian vegetation as a part of the adaptive management plan. These are relatively cheap and objective ways of evaluating whether or not groundwater levels are declining and may affect riparian ecosystems.

II. Species Level Questions:

All Species

1. If the conservation areas for sand dependent species are concentrated in the dune systems north of Interstate 10, will this be sufficient for those species over the long term if the dune systems south of Interstate 10 are eliminated?

Regarding the sufficiency of the dunes conserved north of I-10 for long-term needs of sand dependent species, the short answer is not for all species. Although some species have relatively broad tolerances for temperature and moisture regimes, others have much more narrow tolerances. For the latter species (especially those unable to fly), it is critical to maintain landscape linkages to allow them to track the changing limits of their essential habitat parameters. Historically, the largest contiguous dune system was south of I-10; it linked dune habitats in the center of the Valley with sandy habitats and sand sources extending to the western limits of the plan area. This dune system spanned a relatively broad and dynamic gradient of temperature and moisture conditions, permitting similarly dynamic range adjustments for many species. The central dune system is now fragmented and can no longer support such species range adjustments. Dunes north of I-10 are much less extensive and less connected to one-another; they are also cut off from the remnant southern dunes by I-10 and by the railroad. Thus, linkages among the dunes north of I-10 are tenuous and the ability of their flightless inhabitants to track climate-related changes in habitat distribution are impaired. The physical isolation of dunes north of I-10 makes their sand-dependent inhabitants more vulnerable to extirpation when climatic or other external conditions change, than would the same species in the southern dune system prior to its fragmentation

Only one covered plant species is known to occur on the Big Dune south of I-10, the CV milkvetch. This species occurs in active and stabile sand and has a high probability of persistence on the Big Dune even though it is no longer geomorphically active. Alternatively, CV milkvetch distribution is extensive enough elsewhere that it will survive even without protection of Big Dune.

A more definitive answer to the question proposed here is strongly desirable, but it will requireCas a startCbiological surveys of the Big Dune. In the interim, we suggest that the Big Dune be protected from development. Although it seems certain that the Big Dune is limited on process (i.e., sand movement), this does not entirely negate its habitat values. Whether or not to include the Big Dune in the proposed reserve system should be decided on the basis of adequate biological data. While data may eventually confirm the availability of the Big Dune for economic development, we believe it should not be eliminated up front simply on the basis of high land values and little or no biological information.

2. *If full build-out were to occur under each jurisdiction=s general plan up to the boundary of the conservation areas, and 10% of each parcel inside the conservation areas could be developed, which target species might be affected and how; particularly in areas with multiple small parcels?*

Again, this is a question that peer reviewers cannot answer acceptably. It is impossible to answer this question without knowledge of the exact pattern and nature of each development project. At this point in time, data do not exist to understand the mechanisms by which this level of build-out will affect the Coachella Valley ecosystem. Nevertheless, the notion of 10% build-out on each parcel inside the conservation areas is one of the most troubling aspects of the Draft Plan. It is certain to lead to habitat fragmentation within reserves unless the development process can be intelligently regulated such that habitat destruction is limited to marginal areas. Clustering, especially on reserve margins rather than centrally, is a much less disruptive pattern of development than scattered build-out. Roads would increase greatly under a scattered vs. a clustered pattern, perhaps to the point that the total surface area occupied by roads constitutes a substantial loss of habitat reserve-wide. Unfortunately, we do not find a rigorous assessment of this problem in the Draft Plan.

A number of covered species can be expected to decline unless the 10% build-out allowance is eliminated or confined to reserve areas with low habitat values. For example, given the probable increase in a highly subsidized cat population in the vicinity of residential subdivisions, the two small mammals covered in the Plan (Palm Springs ground squirrel, Palm Springs pocket mouse) will be negatively affected. Fire frequency also can be expected to increase, with uncertain effects on covered species. With regard to the covered sand-inhabiting orthopteroid insects (CVJC, CVG, CVGSC), simply taking out 10% of the habitat on each parcel (e.g. paving over 10%) would probably cause a simple 10% reduction in population size. However, the loss could be much greater depending on how the land is modified. For example, landscape trees and shrubs could alter sand deposition, introduce invasive weedy plants, and alter insolation by shading. This uncertainty might be overcome by implementing strict land use guidelines for landscaping, such as prohibiting certain invasive species and prohibiting or limiting the height of ornamental trees and shrubs. It would be helpful if only native plants were used in landscaping.

3. Were area requirements, habitat and connectivity needs and life histories adequately addressed and documented for each species in the development of conservation areas?

Our general answer to this question is Aapparently not,@ but we acknowledge that data to consider area requirements, habitat affinities, and connectivity requirements from the standpoint of each species= autecology were sparse. The Draft Plan gave general consideration to autecological requirements in constructing the species-specific habitat models. Nevertheless, than Plan should have considered connectivity issues, in particular, more thoroughly. See our response to question #4 under Species-Specific for some suggestions concerning connectivity.

4. Were appropriate biological parameters and/or landscape features used to estimate a minimum patch size of suitable habitat for inclusion in the conservation area design for each species?

This question has two basic components. First, AWere appropriate biological parameters . . . used to estimate a minimum patch size of suitable habitat for inclusion in the conservation area design for each species?@ Many people use the term Aparameter@ (meaning a value or state of a variable) as a synonym for Avariable.@ Because the context does not help in figuring out which concept was meant, we assume both were meant. In general, we believe the planners used reasonable factors (variables) in the conservation area design. In many cases, of course, data were not available, so surrogate variables were used. We are impressed by the knowledge and skill of the biologists working on this project (i.e., the SAC) and have no reason to doubt that reasonable (best available) variables were used.

With regard to Aparameter@ selection, the models used to determine suitable habitat for the various covered species are not formal population viability (PVA) models (see our response to Species Modeling questions); in other words, they do not involve the use of precise parameter estimation and testing. Therefore, although this question is interesting, it is not relevant at this stage. It might become relevant, however, as time goes by and PVAs are carried out as part of implementation, monitoring, and adaptive management.

Second, AWere appropriate . . . landscape features used to estimate a minimum patch size of suitable habitat for inclusion in the conservation area design for each species?@ In most cases, this question is the same as the question above assuming that Alandscape variables@ and Avariable@ mean the same thing. Where adequate knowledge of particular species is available, we support the choice of landscape variables used in the models.

The more important issue, perhaps, is that of Aminimum patch size.@ We assume that the questioner has in mind some minimum (critical) area necessary for the persistence of the species population over a reasonable length of time. It is impossible, however, to engage in a serious discussion of this question unless the issues of Ahow long@ and Aprobability of persistence@ are specified for each covered species individually. To do this, of course, requires many years of demographic information and a formal PVA. At best, these data are available for one or two species, so the question, on its face, could be described as academic.

To be fair, however, we should address the underlying issue, which is Adoes the minimum patch size (or overall area protected) for each covered species make sense based on the intuition of conservation biologists?@ Unfortunately, though, even this question requires some information about the annual variability of the relevant ecological variables, knowledge of existing or potential edge effects, consideration of demographic stochasticity, degree of connectivity for each species, etc. For example, a small patch that can sustain a mean population of 10 individuals of an animals species with an average lifetime movement distance from the natal site of 300 meters and located several kilometers from other patches would fail to pass the Alaugh test.@ On the other hand, such a patch located between 200 and 400 meters from a larger site might constitute a reasonable conservation site in a metapopulation model, assuming there were no impassable barriers to dispersal.

As noted elsewhere, we are concerned that the suite of potential reserves in Alternative 2 is potentially insufficient from a biological standpoint. Yet how much of Alternative 3 is beyond the necessary amount of habitat to sustain the covered species and natural communities is highly uncertain, largely because of data limitations. Most importantly, the question of how much habitat is needed cannot be answered without considering details of management. Hence the importance of having an adequate adaptive management plan. Without ecological management, much larger areas of habitat are usually necessary to sustain a suite of target species. Conversely, smaller areas can be adequate given sufficient management.

Insufficiency is an almost inevitable result of considering non-biological factors, such as cost of purchasing private property, in the initial selection of conservation areas. If one were less concerned with land costs and availability, it would be prudent and ethical to give the benefit of the doubt to the speciesCto employ the precautionary principle with regard to rejecting possible sites. This is particularly reasonable when little is known about the critical factors that determine long-term persistence, which is generally the case for the covered species in the Coachella Valley. Certainly non-biological factors, such as economics, must inform the final selection of conservation areas and the mechanisms by which these areas are protected and managed. Our concern is that when economic and political factors are brought into consideration early in the design and planning process, they constrain biological options and make the choice of conservation areas less defensible scientifically. As we have stated earlier, it may be that the final plan must balance the economic and political feasibility of some of the proposed biological conservation areas with their necessity as protected areas. But to make that judgement at the selection stage, particularly in the absence of documentation about what those non-biological factors are, undermines the defensibility of the proposed conservation program.

To the best of our knowledge, the best available information was used to determine the habitat needs of the covered insect species. Unfortunately, there are no definitive values for minimum habitat patch size for any of these species. Furthermore, the rapid pace of habitat conversion to other uses, together with habitat fragmentation and other environmental changes, does not permit an accurate assessment of long-term effects on species viability with respect to habitat patch size. This information can only come from future studies. This is why an effective adaptive management plan is so important.

5. Are the data provided on the habitat requirements and ecology of narrowly distributed endemics sufficient to design conservation alternatives and management methods?

This question has two parts. First, one must understand what a Anarrowly distributed endemic@ is.

Second, one must decide if the understanding of these species= life histories, population dynamics, and habitat requirements is sufficient to design conservation alternatives.

Based on species descriptions in the Technical Appendix, the following species are found only in Coachella Valley and might be considered narrowly distributed endemics: CV Jerusalem cricket, Casey=s June beetle, Coachella giant sand-treader cricket, triple-ribbed milkvetch, and the CV fringe-toed lizard. Additional species are found primarily in the planning area, with some populations located outside: CV milkvetch, Little San Bernardino Mountains gilia, Mecca aster, Orocopia sage, Palm Springs ground Squirrel, and the Palm Springs pocket mouse.

In general, knowledge of the above species consists primarily of distributional data and perhaps estimates of abundance in each location. (Obviously, the level of information varies across species, with the perhaps the best data being available for the Fringe-toed lizard.) Virtually nothing is known about the demographic or genetic patterns and processes in most of these species. Thus, designing conservation alternatives for these species cannot, at present, be based on high quality, rigorously collected data.

Specifically, understanding how alternatives 2 and 3 will differentially change the ability of the Plan to conserve viable populations of the above species is fraught with high levels of uncertainty. The primary method of comparison is to overlay Alternatives 2 and 3 on the predicted distribution for each species and determine which alternative covers a sufficient amount of the predicted distribution for each species.

There are a number of reasons why this method may contain substantial error. First, the predicted species distribution maps may not be correct. In rare cases, so little is known about a species that a predicted distribution was not created (i.e. Jerusalem cricket). In cases where the species distribution were predicted using GIS overlays, there is no information regarding the validity of these distributions. Validation could be achieved by surveying randomly selected locations within and outside the predicted distribution of each species, then determining how frequently the GIS model correctly classified a location in terms of presence or absence.

Second, errors of omission could lead to substantial uncertainty when designing or choosing between alternatives. The current comparative method does not include information regarding how population dynamics and genetic structure will interact with each of the alternatives to determine overall viability of the narrow endemics. This is not a fault of the SAC, but merely a limitation of the data available. Nevertheless, the simplistic methods used create uncertainty in the design and selection process that should be acknowledged.

Species-Specific

1. Is it critical to maintain the habitat at the east end of the Indio Hills to sustain populations of the Palm Springs ground squirrel and the Palm Springs pocket mouse rangewide?

Information provided on the biology of this species and the spatial configuration of the Plan is not adequate to answer this question with a high level of certainty. The ability of the Plan (or any given alternative) to cover the squirrel will depend on the interaction between the spatial ecology of the squirrel (i.e. how population dynamics occur across space) and the final spatial configuration of the Plan. The following types of information would increase our ability to understand how habitat in the east end of Indio Hills affects the ability of an alternative to sustain the squirrel:

A) Higher quality distribution maps. Currently, the distribution map for this species consists of 103 locations across a predicted 103,207 acres, or 1 point per 1,000 acres. Data on habitat requirements consists of descriptions of habitats in which the species was found. Detailed, longer-term studies of spatial variation in density, reproductive success, survivorship, and other demographic parameters across habitat gradients are lacking. Thus, there is the potential for error in the identification of the core habitat for this species.

B) Understanding how the species responds to habitat fragmentation. Given the relatively low density of this species reported in the technical appendix, large areas may be required to maintain viable populations within any given area of the Plan. How habitat fragmentation, including low levels of development within conservation areas, affects population dynamics and dispersal is critical to understanding the contribution of habitat east of Indio Hills toward overall viability.

C) Factors regulating population size. Generalizing points 1 and 2 above, little is known about the factors that regulate population size in this species. Preferred habitat seems somewhat identifiable, but having a detailed understanding of those factors influencing density at a given locality would increase our ability to identify suitable habitat and determine management strategies.

D) The dispersal ability of the species/historic patterns of gene flow. One argument against including habitat east of Indio hills in the Plan is that it represents a disjunct population and hence adds little to the overall population throughout the reserve. However, we know nothing about the dispersal biology of this species, average dispersal distances and how connected populations were prior to the current urbanization of the Valley. Given such a dearth of information, we do not know if populations in eastern part of the reserve were always disjunct from more western populations or were recently isolated. Indeed, we do not know if the habitat connections between the core areas found in both alternatives in the western part of the reserve are even necessary to maintain demographically critical dispersal or gene flow.

Understanding the dispersal biology of the species would allow one to understand the spatial distances at which populations of ground squirrels become demographically isolated and what habitat types make corridors functional for this species. In addition, many small mammal species show sex and age biases in dispersal. This information may be critical in designing translocation programs, if they are needed. Genetic data would greatly assist the decision making process by describing the historic patterns of gene flow, and hence historic connections between populations, prior to urbanization. This information would improve substantially the identification of core areas and critical habitat linkages. In addition, the data would be useful in adaptive management because they may suggest specific translocation scenarios in situations where creating or maintaining habitat corridors is impossible.

E) A better understanding of how build-out will take place within the planning area. Despite the focus on Alternatives 2 and 3, both represent general Aoutlines@ of the ultimate hard boundaries of the Plan. Particular pieces of land designated as reserve in the Alternatives may be considered critical for development by stakeholders or too expensive to add to public ownership. As such, we cannot be certain of the final spatial configuration of the plan or the densities of urbanization in particular areas of build-out. Hence, the east end of Indio Hills may end up supporting a key population(s) of the squirrel depending on how areas to west are ultimately delineated during the negotiation process between stakeholders and the wildlife agencies.

2. Is the proposed corridor between the east end of the Indio Hills and Dos Palmas sufficient to maintain potential for demographic interchange for the Palm Springs ground squirrel and the Palm Springs pocket mouse?

In short, there is insufficient information to answer this question. The data needed to answer this question are described in the response to the previous question regarding the dispersal ability of the species and historic patterns of gene flow.

Nevertheless, given the large distances involved and documented dispersal distances of similarly sized small mammals, it is unlikely that populations separated by the distances between Indio Hills and Dos Palmas were ever Ademographically@ connected in the sense that dispersal from Indio Hills populations had regular (annual or within a generation), demographic impacts on populations in Dos Palmas or vice-versa. Metapopulation-like colonization events probably took place between the two areas in the past (or even now), which would have connected the populations genetically as multiple generations of dispersing individuals moved genes between the areas, but there is no evidence of such connection.

3. *Is a linkage between Willow Hole and the upper Mission Creek necessary for the long term persistence of the Palm Springs pocket mouse?*

This question boils down to whether or not the different levels of connection between Willow Hole and Upper Mission Creek proposed in the alternatives will differentially impact the long-term persistence of the pocket mouse. There are two critical biological issues that must be resolved to answer the question. The first is basically the question asked of the review panel, is immigration between the populations on either side of the proposed corridor necessary for persistence? However, another question is critical as well: Will the corridor function differently (or at all) under the two alternatives?

Insufficient data exists to answer either question adequately. The following types of information would help determine the role of immigration to overall persistence.

A) The population demography of pocket mice. If populations show large fluctuations in numbers and local extinctions, then immigration between locations will become critical for recolonizing sites. If populations are more stable and rarely go extinct, immigration between sites is demographically less important. What role immigration plays in overall population persistence in this species is not known.

B) Estimates of gene flow between pocket mouse populations on either side of the proposed corridor. If these populations are genetically distinct with little gene flow, then historical immigration between the populations was rare. In this case, immigration may not be critical to long-term persistence. The alternative is that the populations are genetically indistinguishable and gene flow did occur. Analyses using mitochondrial DNA would be appropriate given the distances between populations.

In order to determine the difference between the two alternatives in their ability to promote movement of pocket mice between populations, information is needed on the spatial distribution of pocket mice in the area. If pocket mice are found in the two drainage canals, then it may be possible that they would continue to use these features in the future. This assumes that use of the drainages by pocket mice will not change as development takes place or if the design of the drainages is altered. Detailed demographic studies in these canals could determine if they are used for dispersal (short persistence times and no reproductive activity), or actually support populations of mice (longer persistence times, newly weaned offspring occurring seasonally, reproductive activity).

If surveys indicate the mouse is found in the contested area (i.e. Alt. 3), but not in the drainage systems (Alt. 2), then Alternative 3 would be preferred, assuming additional build-out of the current low density urbanization in the Alt. 3 area does not continue.

It is obviously desirable to maintain suitable habitat wherever possible. The area in question, however, already is partially developed and disturbed and could even be (or shortly become) a demographic sink for this species. Moreover, there is an approved specific plan for development in the future. This raises many questions. Would restrictions on off-road-vehicle use in the area be reasonable, practical, and beneficial? Also, given increasing density of housing and the vast increase in subsidized house cats that this implies, is survival of the mouse likely in this area? (Even low-density housing in the area could restrict opportunities for the survival of a viable population.) Would it be possible to design and protect a linkage zone connecting these two localities? Would fencing of such a linkage keep out cats and human recreational use that would compromise the biological utility of the linkage?

Ultimately, whether or not a linkage between Willow Hole and Upper Mission Creek is needed is unknown given all the uncertainties of current and future distribution of the mouse, not to mention the absence of reasonably good PVA for the species; such a PVA is probably not a realistic expectation given the level of information now available. If funding were to become available, however, such a PVA should be performed. Because the mouse is known to exist at several localities between Willow Hole and the Salton Sea along the eastern side of the Coachella Valley (a distance of about 50 miles), a barrier to movement between Willow Hole and Upper Mission Creek is not likely to jeopardize persistence during the next century or so, depending, of course, on the development pattern in the planning area as a whole.

4. Have adequate connections been maintained within the plan area and to populations outside of the plan area for target species?

Connectivity for genetic exchange and to assure repopulation of depleted populations (the Arescue effect@) are important features of any conservation plan. Although an argument has been made (for example, by Dan Simberloff and colleagues) that corridors without proven values for species are ill-considered, this suggestion poses a high risk of Type II error. Natural landscapes are fundamentally connected, but this connectivity is often broken by human activities. Conservation strategies do not attempt to create corridors between habitats that were naturally isolated, but rather to maintain, and where possible restore, natural connections (R. Noss, 1987, *Conservation Biology* 1:159-164). The precautionary principle suggests that the appropriate null hypothesis is that severing natural connections has no ill effects on biodiversity. Accepting this null hypothesis, if it is incorrect, would have serious consequences. Hence, the burden of proof should be placed on those who would reduce natural levels of connectivity (P. Beier and R. Noss, 1998, *Conservation Biology* 12:1241-1252). Again, we urge more consideration to assuring sufficiency and less to proving necessity.

The Coachella Valley Plan has one major connection across the Valley in the north, crossing Rt. 111, I-10, and Dillon Road. It consists of Alternative 2 and 3 patches. In some areas Alternative 2 forms a narrow corridor, and addition of Alternative 3 lands would increase the width and possibly the security of the corridor. Target animals such as desert bighorn sheep may not necessarily use this corridor, as they usually will not cross highways, but the corridor may provide connectivity for other large mammals not covered by the Plan, as well as potentially many smaller-bodied animals, especially if modifications of roads (wildlife crossings) can be made.

A second potential major connection not addressed in the Plan is the Whitewater River channel. It runs east-west across the Valley through Palm Desert and Indio, then south to the Salton Sea. It is not currently a viable connector for many species, as it has been channelized. However, it is not fenced, and might be a connection for species not highly sensitive to urbanization such as coyotes. Coyotes, in turn, can help maintain populations of native birds through their top-down regulation of opportunistic mesopredators (K. Crooks and M. Soulé, 1999, *Nature* 400:563-566). The possibility of preserving lands to increase animal movement via the Whitewater River should be pursued, as well as potential restoration of the river channel that might make it a corridor for additional animal species. A north-south linkage could be restored by stopping dredging and clearing the Whitewater River upstream from its juncture with the San Gorgonio River and the triangular area were added, as proposed under Alternative 3.

Other potential wildlife corridors running east-west through the Valley are railroad and highway rights-of-way, which might also be restored. Furthermore, canals are likely barriers to movement of a number of species. Land bridge (i.e., running the canal below ground) in strategic places could significantly reduce the barrier effects. The potential of these options to improve connectivity for covered and uncovered species should be addressed in the Plan.

A third major connection across the Valley is on the north end of the Salton Sea. This is currently mapped as agricultural, but salinization is increasingly causing abandonment of farmland adjacent to the Sea. Native saltbush and exotic tamarisk are colonizing this land. Even though it is not pristine habitat, it may be a useful dispersal corridor. Although much of the land in this area is Indian-owned and therefore outside the jurisdiction of the Plan, other lands that are not yet developed should be considered in the Plan. Again, restoration is a major issue in considering these lands.

Several additional smaller-scale connections occur in the Valley. The unexpected development plans between Dillon road and Joshua Tree National Park need to be countered by preservation of additional adjacent lands to improve connectivity to the Park. Desert washes should be preserved as corridors where they may provide for animal movement, for instance in the Alternative 3 lands on the northeast of the Salton Sea. The Asand channels@ north of I-10 may also be corridors for animal movement, especially if the adjacent lands are not developed any more densely than at present.

We emphasize, again, that while a corridor is often a hypothesis rather than proven fact, the option for keeping corridors should not be closed until the function of the purported corridor is known. Corridors may be especially important for movement of organisms during times of environmental stress. Global change may bring warmer temperatures and possibly higher rainfall to the Coachella Valley, and may necessitate animal dispersal as natural habitats change. The future of vegetation change in the Coachella Valley is uncertain, but allowing natural movement is one way to allow organisms to search out suitable habitat. Maintaining as much connectivity as possible is a safeguard against future extinctions.

Species that require connectivity at very broad spatial scales in the planning area include large mammals that are not covered by the plan (e.g., mountain lion). Bighorn sheep are thought not to move across freeway underpasses, so the opportunity for movement of this species may already be lost. (On the other hand, it is not unlikely that very wide underpasses, or better yet, land bridges, would be used for movement.) Historically genetic exchange occurred mainly when individual rams would move between populations, as has been documented for Rocky Mountain bighorn sheep. The existing and potential corridors outlined in our response to the previous question will be more useful to vagile non-target mammals, mainly predators.

In the event of climate change, it is almost certain that some populations of species dependent on narrow environmental parameters will dwindle in size and may be extirpated, while others may flourish. Populations of flightless sand-dependent organisms are now largely fragmented by transportation corridors and other anthropogenic habitat alteration activities which have carved up the once-contiguous large dune systems. To a large extent species persistence will depend on whether habitat linkages to potential refugia are maintained. The insect most likely to be adversely affected is Casey=s June beetle. Because the females are flightless, this species cannot adjust its range rapidly. This species is already essentially locked into a few small enclaves surrounded by urban barriers to dispersal.

Connections between the Coachella Valley planning area and other landscapes are potentially important for several species. Again, adequate data are lacking, but a precautionary approach dictates conservation of existing linkages. Species in this category include large mammals (e.g., bighorn sheep and such uncovered species as mountain lion, coyote, bobcat, and kit fox), the desert tortoise, and the CV milk vetch, Little San Bernardino Mountains gilia, Mecca aster, Orocopia sage, Palm Springs ground squirrel, and Palm Springs pocket mouse. Research is needed on the dispersal behaviors of these species in order to identify plausible corridors.

III. Habitat Monitoring and Management Questions.

1. What basic principles and testable hypotheses for monitoring and adaptive management would be appropriate in the plan area? Are these included in the proposed management program?

Please refer to Appendix B for a summary of what our team feels a defensible science-based adaptive management program might look like. The current proposal for monitoring and adaptive management in the Coachella Valley MSHCP is based entirely upon a one-species-at-a-time process, which we do not believe is the most efficient or auspicious approach. The Adaptive Management and Monitoring Program document we reviewed is confusing and statistically difficult to defend. Moreover, it is probably not an optimal use of the limited funds likely available for management.

The essence of the currently proposed program consists of gathering count data on various species while simultaneously measuring a host of independent, potentially explanatory variables, then using multivariate analyses to partition the variation in numbers of individuals across the suite of explanatory variables. Unfortunately, the population dynamics of desert species are typically so dramatic and precipitous (in response to natural fluctuations in the environment) that it is nearly impossible discern anthropogenic causes of change. Hence, the data derived from a monitoring program of this sort is unlikely to provide information to managers that will be useful for adaptive management, that is, for changing management practices to better serve the goals of the conservation plan.

The proposed Coachella Valley monitoring program suggests using a less volatile measure of populations such as reproductive output. However, this method has been hypothesized to work for fringed-toed lizards only because there are 1.5 decades of data upon which the approach has been evaluated. The method would be much less appropriate for other covered species in the HCP, for which data are considerably more limited. Considering each covered species individually also has considerable drawbacks (R. Noss, M.. O=Connell, and D. Murphy, 1997, *The Science of Conservation Planning*, Island Press). As discussed earlier, a more promising approach would be to classify species into conservation guilds (for example, vulnerability guilds or habitat guilds). In such an approach, similarities in habitat affinities, life histories, and responses to habitat alteration and management would need to be identified quantitatively enough that the wildlife agencies would be convinced that conservation of some species, through habitat protection and management, will also conserve other species in the covered list.

The most promising kind of monitoring currently proposed for the CV-MSHCP appears to be that used to assess the extent of various kinds of sand using digital IR and GIS. For some species, this method measures the extent, and potentially the fragmentation, of suitable habitat. Hence, this approach could be used to assess trends in habitat patterns quickly and effectively. We suggest that this approach be pursued at the initiation of the adaptive management program.

At the very least, the monitoring and adaptive management program should develop process models of how the systems work. Validation monitoring (see Appendix B) should be an important aspect of the program from the outset. It will be necessary to establish a record of implementation of management prescriptions and devise a plan to assess the efficacy of those prescriptions. This requires hypothesis testing and validation research as well as effectiveness monitoring.

We recommend using Appendix B as a template of how to structure a monitoring and adaptive management program in the Coachella Valley. Furthermore, two issues not directly addressed by the Plan, but which will affect future management, are global warming and air pollution. In addition to becoming warmer in response to elevated CO_2, the southern California deserts will receive more moisture under one global warming scenario (R. Nielson, 1998, Pp. 439-456 in R. Watson et al., eds., *The Regional Impacts of Climate Change. An Assessment of Vulnerability. Special Report of Intergovernmental Panel on Climate Change Working Group II.* Cambridge University Press). The net impact to flora and fauna is impossible to predict, but monitoring is needed to detect vegetation change. Invasions of exotic plant and animal species are occurring rapidly and may be exacerbated by climate change. Exotic *Bromus rubens* responds to elevated CO_2 by increased growth more than native species, which may in part explain its increasing abundance in recent decades (Smith et al. 2000, *Nature* 408:79-82.). The monitoring in this Plan will not detect the causes of vegetation change, but will point to the need for research to determine the causes of plant and animal invasions.

Air pollution is of increasing concern in the desert as coastal urban areas grow and as local growth in the desert creates its own air pollution. The main concerns for vegetation are nitrogen oxides and ozone that originate from automobile exhaust. Ozone levels are likely not high enough to cause acute physiological damage in vegetation, although effects of longterm, low levels are more difficult to predict (E. Allen et al., in press, *Air Pollution and Vegetation Change in Southern California Shrublands. Proceedings of the Symposium on ΑPlanning for Biodiversity: Bringing Research and Management Together@ Feb. 29-Mar. 3, 2000*). Nitrate deposits on plant and soil surfaces and accumulates in the soil, unlike ozone, which dissipates. The Coachella Valley may also experience ammonium deposition from agricultural fertilization and possibly emissions from the Salton Sea. Nitrogen deposition is known to cause vegetation change in ecosystem types globally. It may enhance invasions of exotic species by differentially increasing their productivity compared to native species. There is evidence for this in southern California coastal sage scrub (E. Allen et al., 1998, *Proceedings of the International Symposium on Air Pollution and Climate Change Effects on Forest Ecosystems, Riverside, CA February 5-9, 1996;* E. Allen et al., in press, *Ibid*).

Nitrogen fertilization in the desert caused an increase in the exotics Mediterranean split grass and storksbill* (M. Brooks, 1998, *Ecology of a Biological Invasion: Alien Annual Plants in the Mojave Desert. Ph.D. Dissertation, University of California, Riverside;* M. Brooks, 2000, *American Midland Naturalist* 144:92-108). Increased productivity is expected only in wet years, which may be followed by fire in the next dry season. Thus nitrogen deposition may be enhancing the fire cycle, which was previously virtually unknown in the desert. Remote sensing methods need to be calibrated to detect these invasions. The intensive density counts of exotics proposed in the monitoring plan are probably not required. Air pollution is monitored by the California Air Quality Management District in stations in Palm Springs, Indio, Joshua Tree NP, and other desert locations (http://www.arb.ca.gov/aqd/namslams/map_all.pdf), so data will be readily available to local land managers. Again, the causes of vegetation change is a research question. Nevertheless, nitrogen deposition and global change should be listed in the models as potential drivers of weed invasion, along with fragmentation and land disturbance.

*Mediterranean split grass (*Schismus barbatus*) and storksbill (*Erodium* spp.) are not listed in the text as two of the major invasive species. As they increase, they may be responsible for a decrease in native plant species richness.

2. What management actions can be taken to minimize the impacts of roads on species and habitats?

This topic is essentially unexplored in the Draft Plan. As noted earlier, the Plan implicitly assumes that the barrier and other effects of roads cannot be modified to reduce their impacts. Experience in many regions, however, has demonstrated that wildlife crossings, ranging from culverts to overpasses to land bridges, can be effective in reducing the barrier effects of roads, as well as roadkill. Responses are highly species-specific, however, so mitigation measures must be carefully tailored to the species in question (e.g., V. Keller and H. Pfister, 1997, Pp. 70-80 in K. Canters, ed. *Habitat Fragmentation and Infrastructure*; A. Clevenger and N. Waltho, 2000, *Conservation Biology* 14:47-56). We recommend that this topic receive increased attention in the final draft of the Plan.

Insofar as ground-dwelling sand-dependent arthropods are concerned, minimizing the number of roads would have a salutary effect. Where roads cannot be avoided it may be better to pave them than to leave them unpaved. At least some ground-dwelling beetles avoid non-habitat substrates. Thus, a hard paved surface could create a minor barrier to such insects while a soil-surface road might not. The benefit of the former depends on how frequently the road is traveled. Frequent traffic on an unpaved road might cause more road-kills than on a paved road. This hypothesis has been tested in Europe but needs confirmation with regard to the local fauna and habitat conditions.

3. As part of the monitoring program, is a set, quantitative Trigger Number the best method to detect declines in populations and to initiate management responses, or can deleterious trends be separated from expected fluctuations to more accurately trigger a management response?
This issue is addressed in Appendix B. Although some form of monitoring to provide a measure of a species population status over time is often desirable, it is often not possible to set any particular trigger number to initiate management responses. This is especially true for short-lived species, such as annual plants and most insects. Normal annual or seasonal fluctuations in populations of such short-lived organisms usually cannot be distinguished from declines based on habitat degradation. Instead, management decisions should be based on other measurable factors, such as changes in sand deposition patterns and habitat invasion by exotic weedy plants and animals. For long-lived plants and animals (e.g. desert bighorn sheep, Orocopia sage), real deleterious trends in population size are more easily detected and a quantitative trigger might be appropriate to initiate corrective management practices. Nevertheless, trends analysis can often be more useful than the setting of simplistic management thresholds.

Regarding the Coachella Valley giant sand-treader cricket and Coachella Valley Jerusalem cricket, population monitoring, if desired, can be accomplished by oatmeal baiting as an alternative to pit-fall trapping. The use of oatmeal bait trails for surveying crickets of many types is commonplace and can be superior to pit-fall trapping. The oatmeal bait method generally produces quicker results with greater probability of locating crickets during a given evening (when they are active) than does pit-fall trapping. The bait survey also eliminates the possibility of unwanted cricket mortality; they dessicate rapidly and are also more prone to predation if rodents or scorpions end up with them in the pit-fall trap. The main drawback to oatmeal trapping is that it requires intensive labor.

IV. Geomorphology:

In general, the four questions posed here are too specific for the advisory committee to respond to in a quantitative fashion, as is implied by the specifics of the questions. For the most part, these are questions to guide future research, not questions for peer reviewers. Nevertheless, we offer preliminary responses to these questions below.

1. What is the relative contribution of sediment from each canyon in the Little San Bernardino Mountains to the Thousand Palms dune system?

This is a question that would require a research project to answer accurately, but a rough estimation could be gleaned from sediment-yield estimation techniques developed from other desert regions. There are numerous ways for estimating fluvial sediment yield, separated in part by approach. Some methods are purely empirical, fitting statistical functions (typically power functions) to empirical data (K. Renard, 1972, Sediment problems in the arid and semi-arid southwest, in *Proceedings, 27th Annual Meeting, Soil Conservation Society of America: Portland, Oregon*, p. 225-232). Other approaches include more-intensive statistical modeling (E. Flaxman,1972, Predicting sediment yield in Western United States, *Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers*, HY 12, p. 2073-2085) and deterministic sediment-yield models that are highly data intensive (e.g., J. Gilley et al., 1988, USDA Water erosion prediction project. Symposium proceedings, pub. 07-88). In the Coachella Valley, where little sediment data has been collected, the best technique is to apply an empirical function from another region. For example, from the Colorado Plateau, one estimator is of the form:

$$Q_s = 193 \cdot A^{1.04}$$

where Q_s = sediment yield (Mg/yr) and A = drainage area (km^2) (R. Webb et al., 2000, *Geological Survey Water Resources Investigations Report* 00-4055, 67 p.). The point is that sediment yield generally is a strong power function of drainage area, although often the relation is nearly linear (exponent about equal to 1). Therefore, sediment yield (and therefore the sediment contribution) can be estimated primarily from the drainage area. Several canyons then become important, particularly Long Canyon upslope from Desert Hot Springs and Fan Hill Canyon, upslope from Thousand Palms Canyon. West Wide and East Wide Canyons are blocked by a dike that effectively removes sediment from floodwaters, eliminating these canyons as sediment sources.

At this time, canyons from the Little San Bernardino Mountains and the Indio Hills are the only significant sources of sediment available for aeolian entrainment and transport. The significance of the sediment yield from these canyons is better evaluated in terms of areas of deposition, which generally are higher on the alluvial fans of Seven Palms Valley and Fun Valley than would be useful for aeolian replenishment of the Thousand Palms Preserve. The major sand source for this preserve was once the Whitewater River system (including Mission Creek and Morongo Wash), but freeway and railroad construction have effectively eliminated this source except during extremely high windstorms.

From a casual examination, it would appear that the Thousand Palms dune system receives sand in several ways: 1) direct sand input from Whitewater River system (now closed off); 2) direct sand input from drainages of the Little San Bernardino Mountains and the Indio Hills (partial closure owing to development of depositional plains); 3) indirect sand input from fluvial sand originating in the Whitewater River system, mobilized into aeolian sand, deposited in the Indio Hills, remobilized in the fluvial system of the Indio Hills, deposited upwind from Thousand Palms Canyon, and mobilized into aeolian sand (see 2); and 4) aeolian sand from Mission Creek, Morongo Wash, and other small valleys north of the Indio Hills that is mobilized into aeolian sand, crosses the divide between Seven Palms Valley to Fun Valley, is mobilized in the distributary flow system on the alluvial fans, and is aeolian entrained and transported into the Thousand Palms Preserve (disrupted by development). Historically, the Whitewater River system was probably the most important source. Now, it would appear that the most important sources are from the Indio Hills and Fun Valley.

2. Is the sand transport system to the east end of the Indio Hills intact? How does agricultural development affect the sand transport system in that area? To what extent did the developed areas on the south side of the Indio Hills provide sand to the east end historically?

As mentioned in response to question #1, above, historically the major source of aeolian sands to the east end of the Indio Hills probably was the Whitewater River system. This source is completely cut off with the exception of sand recycled from the Indio Hills or transported directly during rare, extreme windstorms. Agricultural development will impede the sand transport system in that area or any area upwind of aeolian dunes in the Coachella Valley. The developed areas on the south side of the Indio Hills probably provided little sand but instead were minor fluvial deposition areas from drainages emanating from the Indio Hills. Instead, the major function of this area probably was as an aeolian transport zone where sand originating from the Whitewater River system moved across an aeolian plain and into the Thousand Palms dune system. Freeway and railroad construction have effectively ended this source, so those developed lands probably would have little influence on the aeolian dunes in the Thousand Palms Preserve.

3. Does the Willis Palms drainage supply sediment to the Thousand Palms sand corridor?

This question is too specific given the overall context of the MSHCP; the Willis Palms drainage does not appear on any maps and does not appear to be mentioned in the ARD. However, SAC members have told us the canyon is on the southeast corner of the Indio Hills and deposits fluvial sediments just upwind from the Thousand Palms Preserve. Therefore, it likely is a significant source of aeolian sands for this preserve, given the closure of other major historical sources.

4. How stable are the dunes south of Interstate 10, even if sand sources are reduced or eliminated?

The stability of dunes may be evaluated on several levels. The dunes themselves appear to be very stable, unlike the unidirectional sand-transport systems that characterize the sources for the

Whitewater River and Thousand Palms preserves. These dunes appear to be stopped from east-southeastward movement owing to the presence of railroad and freeway berms. Unlike other dune systems in the vicinity, some perennial vegetation has colonized these dunes, further causing stability. However, within the area of dunes, active sand movement is undoubtedly occurring, which potentially creates habitat for both animals that simply require aeolian sand as well as animals that require active, loose aeolian sand.

The stability of Big Dune is unknown in geomorphic terms, with the exception of information from Lancaster (1993). Stability has two connotations: whether the dune has an active surface layer, which may promote some endemic animals and plants, or whether the sand supply has been cut off. The answer to the latter question is a decided yes. As to the former question, deflation of the dune with no addition of sand may continue to provide habitat for some endemics, particularly insects, and therefore this habitat should not be discarded without significant consideration in the MSHCP.

The true level of stability of this dune system must be evaluated by a combination of historical analysis (using aerial photography and other techniques) as well as monitoring under the Adaptive Management Plan. We suggest that aeolian sand-transport monitors be installed in this area, in addition to sand depth monitoring and photographic monitoring, to determine just how stable this dune system is over the long term.

V. Species Modeling

1. Was enough information on habitat quantity and quality, and species distribution and abundance, available to create accurate models?

This question is impossible to answer until the models have been validated by new survey data or other independent data sets. An accurate model would be one that successfully predicts the location of new data points.

2. Are the assumptions in the species models supported by literature?

Although the ASpecies Distribution Model Parameters and Known Locations@ report documents the decision-making process for including or rejecting GIS layers for the individual species models, we found no detailed discussion of the modeling process or its assumptions and limitations. Except for a couple general references on modeling, no literature is cited to support the use of these particular models or their limitations.

3. Was the process for creating the species models scientifically reasonable and defensible based on available data?

The species models in the Draft Plan are simple GIS overlays and can be described as spatially-explicit conceptual models. Such models are superior to abstract or spatially-nonexplicit models and they are arguably the best that could be produced, given the limited available data. For some of the better-studied taxa, however, particularly the CV fringe-toed lizard but also perhaps several other species with relatively abundant data points, more rigorous models with better predictive power could be developed.

Examples of more rigorous predictive models are several recent approaches based on resource selection functions (M. Boyce and L. MacDonald, 1999, *Trends in Ecology and Evolution* 14:268-272). Using multiple logistic regression, occurrences of a given species are graphed against a series of potential predictor variables. When the relationships are statistically significant (tighter than expected by chance), those variables enter into the habitat suitability model for that species, which is displayed in GIS. An advantage of this approach is that predictions of habitat suitability can be extended geographically beyond the areas for which sightings exist, but within the documented range of the species. For example, C. Carroll et al. (1999, *Conservation Biology* 13:1344-1359) developed a spatial habitat model for the fisher in northwestern California and adjacent Oregon, based on 682 previously surveyed locations, satellite imagery, and derived indices of vegetation composition. The model was validated with new data from 468 survey stations with sooted track plates, at which vegetation measurements also were taken. Habitat quality, measured by number of fisher detections at each station was successfully predicted by the model, with nearly 80% correct classification. The importance of field validation cannot be overstated. Just because a habitat appears suitableCand even if that suitability has been well validated in other landscapesCdoes not mean it is being used by the species in question.

The next step beyond such static habitat suitability models are dynamic, spatially-explicit population models (SEPM), a class of individual-based simulation models that incorporate additional biological realism as habitat-specific demographic parameters. Because both static and dynamic models have strengths and weaknesses, a combined approach offers a unified population viability analysis framework. In SEPMs, individuals not only move between cells, but grow, reproduce or not, and die. Model output from SEPMs may include the mean population size, mean time to extinction, or the percentage of suitable habitat occupied. The development of SEPMs has allowed data gathered from intensive demographic studies to be combined with GIS maps of landscape composition and pattern. These models permit analysis of both equilibrium behavior (i.e, can current habitat sustain the current species distribution for 100 years?) and transient behavior (e.g., can a species recolonize from current refugia or would active reintroduction be necessary?). Analysis of relaxation times, i.e. the time to and pattern of loss of a population after habitat change occurs, allows estimates of the Aextinction debt@ in the region due to past habitat change. We urge development of these combined models in the Coachella Valley for those species for which adequate distributional data and estimates of demographic parameters are available or become so during the adaptive management and monitoring process.

4. What limitations in the species modeling process may result in inadequate or erroneous maps of potential habitat for any of the target species? What might those errors be?

Small sample sizes (few records) and limited knowledge of autecology are obvious limitations for many of the covered species. The potential for errors of omission (failing to predict the actual occurrence of a species) or comission (predicting occurrence where the species is not found) are correspondingly high. The magnitude of these errors can be determined only through intensive field validation.

5. Does an analysis of Aknown locations conserved@ provide enough information to make decisions about the adequacy of conservation for species without models? Should any other factors be considered? What are the potential risks of basing conservation of a species solely on known locations?

Species distribution models should be dynamic, as distributions change over time. Historic distribution records can yield clues about possible future changes in distributions. There are inherent risks in basing a long-term conservation plan solely on known locations. One must also consider likely future changes in the distribution of essential habitat parameters. Furthermore, records for some species (especially insects) are largely artifacts of convenient accessibility. Insect collectors and bird watchers (as opposed to researchers) often return to the same known locations year after year while ignoring many other sites where a given species may occur, but simply has not been reported. There is no substitute for systematic on-the-ground surveys covering all likely or possible locations for a species within a region.

6. To what extent is historical location information useful in creating models and proposing conservation areas?

See previous response.

7. Are there any sources of information not on the list of Source of Biological Data in Table 3.2 that should be consulted?

We are not aware of specific sources of information. This question is best addressed to local biologists.

Appendix A (by Greg Ballmer, Ph.D.)

Notes on Covered Invertebrates

Casey's June Beetle (*Dinacoma caseyi*). Most records of this species are from the edge of the desert floor where it meets the boundary of the San Jacinto Mountains. Recent records are from a very few locations on the Agua Caliente Indian Reservation at the mouth of Palm Canyon and from private land within the Smoke Tree Ranch residential community. Historic records from elsewhere in Palm Springs and nearby communities pertain to areas that have been thoroughly developed or otherwise altered and presumably no longer have appropriate habitat.
Other potential habitat identified by Frank Hovore seems to have a low likelihood of occupancy, but needs to be surveyed to determine whether the species is present. If this species were found to occur within the Plan area further west (Snow Creek/San Gorgonio River Wash is perhaps the most likely place to look), one would be warranted in expressing greater optimism about its chances of long-term persistence. In the absence of evidence that it occurs elsewhere, preservation of this species may depend entirely on the good will and conservation efforts of the Agua Caliente Indians (not included in the Plan) and other private land-owners. The Draft Plan contains no guarantees that either the Indians or other private land-owners will take steps to preserve this species.

Furthermore, in the event of a significant climate shift it seems unlikely that this species will be able to track the likely changes in the distribution of its habitat, as it is probably already cut off from that option. One must question the premise that the Draft Plan offers long-term protection for this species. In order to offer realistic coverage for this species it will be necessary to determine more accurately the extent of its occupied habitat both in known locations and at other sites where potential habitat has been identified. Another possible conservation measure could be active management, including captive breeding and re-release into other suitable areas within the plan area. Success of such measures is speculative and not recommended at this time.

Coachella Valley Giant Sand-treader Cricket (CVGSC) (*Macrobaenetes valgum*)
This species is a sand endemic restricted to the western portion of the plan area from Fingal's Finger to the Coachella Valley Fringe-toed Lizard Preserve. Its range is probably determined by the presence of aeolian sand and a suitable temperatue/moisture regime. Plan Alternatives 2 and 3 preserve 39% and 66%, respectively, of this species' current habitat. It should be noted that significant climatic warming is likely to shift the range of this species toward the western (cooler, moister) portion of its range and, thus, reduce the useful extent of its protected habitat. In that event the additional western lands identified in Alternative 3 might provide significantly more useful habitat and commensurately greater protection from decline and extinction. It seems likely

that sufficient habitat will be protected for this species in both Alternatives 2 and 3 if its current range does not shift greatly.

Coachella Valley Jerusalem Cricket (CVJC) (*Stenopelmatus cahuilaensis*)
The range of this sand endemic is skewed toward the western end of the Coachella Valley, with known locations primarily from Palm Springs Airport westward to Fingal's Finger. This correlates with winter precipitation patterns, which are generally higher and more stable in the west than elsewhere in the valley. Only two records for this species are known from north of I-10. The westernmost of these was reported just this season from a windmill farm on the bluff along the north side of Whitewater Canyon. The extent of this population is unknown but could extend through scattered patches of aeolian sand at the base of the bluffs, as well as further to the north and east toward Mission Creek. The easternmost record for this species is at the Thousand Palms off-ramp from the I-10 freeway. This record is probably an outlier, as surveys elsewhere within the community of Thousand Palms and further to north and east have failed to find it. This species could occur nearby on the south side of I-10 in the vicinity of the Big Dune. In view of predicted climatic shift toward warmer and drier conditions, it seems most important for this species to protect habitat at the western end of its range (especially along the Whitewater River wash from Palm Springs westward to Fingal's Finger), including the expanded lands included in Alternative 3.

Coachella Valley Grasshopper (CVG) (*Spaniacris deserticola*)
This species is a hot desert endemic which does well at elevations around sea level (primarily the valley floor and adjacent bajadas) where its host-plant, *Tiquilia palmeri*, occurs. Several historic sites for this species in the Coachella Valley no longer support habitat. It may now be restricted to sites north of I-10, including portions of the CVFTL Preserve and Willow Hole areas. The distribution of this species further to the south and east needs to be determined. As for the records of this species reported by Matt McDonald from Dos Palmas, near the Salton Sea, and the east end of the Indio Hills, at least some are misidentifications. If historic populations in Imperial County have been extirpated, then those remaining in the Coachella Valley should be considered far more important. Alternative 3 would protect considerably more of the few known sites for this species than would Alternative 2, although there is some question as to whether some of the reported sites covered by Alternative 3 are for misidentified specimens.

Pratt's blue (*Euphilotes enoptes cryptorufes*)
Pratt's blue is confined to the higher elevation chaparral belt in the San Jacinto-Santa Rosa Mountains range. This is a rarely encountered taxon with perhaps no more than three adult individuals having been found in the wild. Most museum specimens were reared from larvae found on the host-plant, Eriogonum davidsonii, which grows in openings in the chaparral and along trails. Because all known habitat occupied by this species lies within the Santa Rosa Mountains National Monument and/or National Forest land, the main responsibility for protecting it lies with federal agencies. Protection should entail proper land management to ensure that the habitat is maintained

to conserve the host plant. This would logically entail a more-or-less natural fire regime and exclusion of activities which could destroy the habitat.

It seems likely that the management plan for this species is adequate.

Appendix B (by Dick Tracy, Ph.D.)

ADAPTIVE MANAGEMENT/MONITORING PROGRAM

Background

The initial conservation measures under the MSHCP start a process of accumulating experience and knowledge. That is, the MSHCP contains a programmatic core feature that is Aadaptive management". The initial MSHCP management actions are those hypothesized to be necessary to mitigate threats to all covered species. However, it is important for the permit holders to admit that:

1. Currently identified threats are **hypotheses** about threats rather than certain knowledge.
2. Initial management actions emanate from **hypotheses** about what is needed to militate against identified threats.

Proposed management actions thus are guesses as to what is needed to militate against guessed-at threats. These guesses (or hypotheses) must be replaced by better knowledge as part of the Amanagement actions@ of the MSHCP. This additional knowledge will only come from a science-based adaptive management program (SBAMP). The work of this program must be entrusted only to those who normally test hypotheses using scientific methods to generate new knowledge.

Those in charge of the Adaptive Management Program must recognize that environmental conditions for species will change, and potentially change dramatically, with time. This is especially true in Coachella Valley where new species will invade the system (e.g., exotic invader species like salt cedar, red brome, argentine ants, etc.). Moreover, physical/chemical changes will occur at high rates (e.g., roads are created or expanded, urban development is created or expanded, fertilizer and/or pesticides are blown into to spring, etc.). New, or modified, management actions will be necessary to respond to continued changes in the environment.

In addition, even after Acorrect@ management actions are identified and implemented, the effectiveness of these actions must be assessed. The process of acquiring and using new knowledge to prescribe changes in management represents the science-based adaptive management necessary to assuage Service concerns about the efficacy of the plan behind the 10A permit.

Adaptive management is a flexible, iterative approach to long-term management of biological resources. Adaptive management is directed over time by the results of ongoing monitoring activities and other information. This means that biological management techniques and specific objectives are regularly evaluated in light of monitoring results and new information on species needs, land use, and a variety of other considerations. These periodic evaluations are used to adapt both management objectives and techniques to achieve overall management goals better. In the case of the MSHCP, these goals broadly include maintenance of the long-term net habitat values of the ecological communities in project area with a particular emphasis on covered species. This includes recovery of listed species, conservation of unlisted covered species, and evaluation of other species for status as covered under the Section 10(a) permit to the permittees.

Science-Based Adaptive Management

Science-based adaptive management is the approach preferred by many resource managers when scientific resources and funding are available. Adaptive management provides resource managers with objective scientific data and analysis upon which to base management decisions. Adaptive management provides those who fund resource management and conservation actions with objective and scientifically valid evaluations of the needs for various actions and a basis for assessing the effectiveness of those actions.

A critical element of a science-based adaptive management program is the database upon which management decisions are made. Such a database can provide the basis for evaluating species, ecosystem, and/or landscape status and trends, and it can be used to evaluate management actions directed at conservation of biological resources. Adaptive management requires a scientifically valid program for collecting scientific data, coupled with supervision of an accessible database by a competent scientific authority and quantitative evaluation of emerging data.

Biological recommendations emanating from the SBAMP for inventory, monitoring, and research ordinarily would be used to establish funding, management, and monitoring priorities.

The primary focus of a SBAMP should be the evaluation of the status of species and ecosystems within the project areas to bear on land-use decisions potentially affecting biological resources in these areas. Specifically, the SBAMP must develop methods to monitor the effectiveness of management actions in meeting MSHCP objectives. For the service, this also requires tracking how the status of each element of the project (e.g., each species) can be assessed under the monitoring scheme.

The SBAMP must establish a geographic information system database for all inventory, monitoring, and research data, and a reliable entity must be invested with authority to keep the database and make it available to all agencies, municipal and county authorities, scientists, and NGOs involved with the project. This entity must ensure long-term maintenance of the database and review of the validity and reliability of the database.

Elements of SBAMP

The inventory and monitoring component of the SBAMP ordinarily would include six steps which, when appropriately linked to decision making, would maximize the collection and integration of objective, reliable data into the decision-making process and help in making decisions about management actions.

a. Identification of Explicit (Quantifiable) Scientific Goals and Objectives

The goals of the scientific program should include "targets" of study at a variety of spatial scales and levels of ecological complexity. Targets of study should range from highly restricted spatial scales for species such as narrow endemics found only in individual desert springs to broad spatial scales for species ranging over most of the Valley in multiple habitat types. Targets of study may range from individual populations to entire ecosystems and landscapes and the physical processes upon which those ecosystems and species depend. Among those targets of study should be specific population characteristics of select species of concern, including federally listed threatened and endangered species, "candidate" species and/or sensitive species, and other species of special conservation concern. Targets of study for ecological communities and ecosystems may include variables associated with composition (which species are present), structure (characteristics like shrub sizes and shapes), and function (such as presence of pollinators, nitrogen fixers, keystone species, and physical processes required by the system). Landscape-level studies will identify targets of study that can be remotely sensed from aerial photography and/or data logging systems. The scientific goals and objectives ordinarily have to be dynamically optimized to incorporate the most current scientific information and respond to changes in goals and direction from those in charge of managing the project.

b. Identification of Likely Environmental Stressors

The SBAMP will identify likely sources of ecological disturbance that can compromise ecosystems and their constituent species. Environmental stressors include both natural and anthropogenic phenomena including climate change, fire, loss of habitat due to fire, toxic pollutants, flood, water diversions, wind breaks, invasions of exotic species, overharvest of species, and so on. Identification and verification of stressors will be the product of research to establish mechanistic links between environmental phenomena and stress to populations, species, and ecosystems.

c. Construction of Conceptual Models Describing Crucial Ecosystem Interactions

Models will outline interconnections (linkages) among physico-chemical ecosystem processes, among ecological communities, and among species and processes within communities. Models are important in developing an understanding of the key ecosystem processes and properties and in developing an understanding of how environmental stressors affect processes predicting extinction events. The models will be important in delimiting the boundaries of what constitutes natural variation in population and ecosystem processes and describing the role of humans in stressing natural processes. Models will incorporate the latest scientific concepts and paradigms, the application of which can contribute to keeping conservation costs low and scientific understanding high.

d. Identification of Indicators

Indicators serve as surrogates and allow inference to be drawn regarding population or ecosystem processes of concern. They can be species or ecosystem components, or characteristics that are easy to measure and exhibit dynamics and responses that parallel more difficult to measure population or ecosystem processes of concern. Indicators are selected because they demonstrate low natural variability but respond measurably to environmental change. Indicators will include population sizes and distributions of select species, physical and biotic variables associated with ecological communities and vegetation types readily assessed by remote methods. Establishing an indicators program requires research into correlative relationships among focal populations and ecosystem and habitat properties and processes. The cost, relative efficacy, and anticipated benefits of such research should be regularly evaluated (along with other alternative conservation measures, alternatives, and proposals) by those implementing the HCP as well as the FWS.

e. Development of Sampling Design to Estimate Status and Trends of Indicators

Hypothesis testing, trend analyses, model development, and statistical inference are elements of a scientific program that will be subjected to independent scientific review. Monitoring exercises must be statistically rigorous so that the program will have the highest probability of detecting ecologically important trends. Sampling design, hypothesis testing, and trend analyses are all scientific processes that continually become more efficient as scientific knowledge increases; thus, experimental design requires continuous evaluation.

f. Determination of Threshold Values That Will Trigger Proposals for Management Changes

Status and trends of species and communities must be used to trigger proposals for adjusting land management and policy. Such data provide the basis for establishing dynamic policies and management aimed at producing the desired ecological condition and the conditions required by the U.S. Fish and Wildlife Service.

Appropriately integrated, an adaptive management program will use direct measurements and surrogate variables (indirect measures of the status of ecosystem processes or species) to determine the status and trends of ecosystems and their constituent species. Resulting data and analyses can lead to recommendations for adaptive management. It is critical to this process that the integrity of inventory, monitoring, and research be assured using the highest standards of scientific accountability and peer review in order for any adaptive management program to promote change to management in the project area, the USFWS, resource managers, and regulatory agencies with reliable and objective.

Adaptive Management Decision Making

An adaptive management framework can allow information to be transferred directly to decision makers and land and resource planners (e.g., BLM, USFS, USPS, Boulder City, etc.) for integration into MSHCP implementation. This information transfer could follow that proposed for effectiveness monitoring for the Northwest forests (see Effectiveness Monitoring for the Northwest Forest Plan - Draft 7 August 1997). The process involves four steps:

$ Provide a range of possible management responses

$ Determine the potential alternative ecological outcomes associated with specific phenomena being monitored

$ Assess the probabilities associated with each possible interpretation of monitoring data

$ Identify the management decision that maximizes the overall "utility" of each decision and outcome (involving considerations of the costs of misinterpretations of monitoring data and/or costs of wrong decisions)

To the extent feasible, species and habitat linkages will be addressed to produce proposals for management that maximize the conservation of ecosystems upon which Acovered@ species depend and that minimize financial costs and disruption of public activities. By linking statistically validated sampling designs with explicit consideration of environmental stressors, any MSHCP would move beyond traditional census approaches that document trends but rarely explain phenomena causes. This will allow the SBAMP process to provide land managers with the scopes of work to support defensible land management decisions.

Inventory, Research, and Monitoring

Inventory, research, and monitoring (IRM) are necessary and important activities for long-term, multiple species HCPs (Fig. 1). Nevertheless, there is confusion about incorporating these activities into conservation planning. The lines separating monitoring and research are not sharp. Indeed, apposite monitoring requires research methods to provide more than anecdotal information; and anecdotal information will be inadequate for both economy-seeking permit holders and for regulatory agencies. Additionally, where monitoring methods do not yet exist, research must be conducted to develop efficacious means to assess the effectiveness of the MSHCP.

Definitions

Inventory, according to Webster=s New International Dictionary (Merriam-Webster 1986), is an itemized list of current assets; as a survey of natural resources such as a survey of wildlife of a region.

Monitoring, according to Webster=s New International Dictionary (Merriam-Webster 1986), is to watch, observe, or check especially for a purpose.

Research, according to Webster=s New International Dictionary (Merriam-Webster 1986), is to search or to investigate exhaustively.

Inventory

A conservation plan designed to protect sensitive populations of wildlife and plants must be based upon knowledge of the status of those populations. The size and spatial distribution of populations are critically important pieces of information upon which management prescriptions can be made. If the status of any population is not known, then aspects of that status can be assessed through an inventory of biological resources, and that inventory should be conducted at the earliest possible time in the planning process. If knowledge about the status of populations is not known before the 10(a) permit is requested, then that inventory should be performed as one of the first actions under the HCP.

Monitoring

A monitoring program without a goal might be viewed as more dangerous than no program at all. Monitoring without goals can consume valuable resources that may be used in other conservation actions and incorrect information from improper monitoring can mislead and direct dangerous management decisions. Monitoring must be conducted with adequate sampling and scientifically defensible sampling protocols. Data must be replicable and have determinable probability of being correct.

There are numerous purposes for monitoring plans, and different kinds of monitoring are necessary and important to a successful HCP. Monitoring is important to validate management actions, to provide better data for adaptive management, and to obtain advanced capacity to respond unforeseen circumstances that. Monitoring can be categorized as implementation monitoring, effectiveness monitoring, or validation monitoring (USFWS 1994). The first two of these forms of monitoring meet the traditional definition of monitoring, but the validation monitoring may be viewed as a form of research (see below).

Implementation Monitoring: Implementation monitoring provides a permanent record of the mitigation and *management actions* under the MSHCP. Implementation monitoring should assess conservation actions such as fencing along roads, recreation restrictions within reserves, prescribed burns or floods, stream and range improvements, pollution regulation, vegetation restoration, and grazing management. Implementation monitoring should also assess the impacts of Anatural implementations@ such as occurrences of drought, natural fires, invasion of exotic species.

Effectiveness Monitoring: Effectiveness monitoring is used to record *responses* of biological resources to management actions and other important natural and anthropogenic events as well as random, year-to-year changes. With sufficient data from different sites through time analyses should be able to separate out non-random changes from a background of random changes. For example, analyses of data from effectiveness monitoring could be used to assess the efficacy of off-highway vehicle restrictions on vegetation or dune systems. They could be used to estimate the impacts of natural and anthropogenic fires or floods. They can be used to assess the growth in animal populations freed from mortality caused by vehicles on roads passing through semi-natural areas. Importantly, analyses from effectiveness monitoring also can be used to assess the loss of biological resources due to aggressive competition, predation, or parasitism by exotic species.

Validation Monitoring: Validation monitoring (USFWS 1994) is actually a form of research. Its purpose is to determine if a Aconceptual model@ of ecological systems is valid. If the conceptual model is correct, then correct prescriptions for adaptive management can be made. Validation monitoring determines if the predictions and assumptions of adaptive management are appropriate to attain the desired objectives. Validation monitoring generally requires experimentation and long-term tracking of ecosystem responses to create a database necessary to validate results from the effectiveness monitoring. Validation monitoring/research thus can be used to assure that the benefits from management actions are not wrongly attributed.

Relationships among Monitoring, Research and Adaptive Management

Adaptive management in the context of a conservation plan requires assessment of the effectiveness of management actions. That assessment occurs through monitoring. Importantly, some monitoring cannot be implemented without preliminary research. The efficacy of a conservation plan requires evaluation of the effects of management in light of hypothesized responses to that management. Different kinds of monitoring are required to make a decision to alter current management practices to reach the desired objectives of the Clark County HCP (see Fig. 1).

AShort cuts@ in monitoring

The information necessary to alert managers to conservation challenges of destructive, non-random ecosystem changes must come from monitoring and research. In complex multiple species HCPs, it is rarely possible to measure all populations covered by the Section 10(a) permit. Time and money are usually inadequate to allow such extensive monitoring; therefore, Ashort cuts@ are necessary to evaluate the efficacy of the plan. Several possible categorizations of MSHCP elements can be helpful in meeting MSHCP goals. These include surrogate species, which can convey substantial information about the status of other ecosystem elements. All species covered under the MSHCP may not be equal in terms of their importance to or influence on other species in the MSHCP, and some species may not correlate in their reaction to environmental events. Below are possible categories of species that can be helpful in assessing the efficacy of the conservation planning.

Fig. 1. Relationships among the desired objectives of the HCP, a conceptual model of the functional relationships among species, and monitoring activities in the adaptive management of the HCP.

Indicators: Indicators are those ecosystem elements (populations, habitat, other) are correlated with populations of covered species or ecosystem elements targeted for conservation. This correlation allows us to measure the dynamics of one population and infer the dynamics of others. Correlations among species generally come from similar reactions by species to similar stressors. For example, if several species are sensitive to drought and all decline in population numbers in the presence of drought, then documented declines in one species allows us to infer that other correlated populations also will decline. Debate over the efficacy of indicator species exists, particularly regarding ecological communities dominated by density-dependent dynamics. It is not possible to identify indicators without research documenting the correlated responsiveness of populations.

Keystone species: Keystone species are those species that have an influence on the population dynamics (and even presence) of a number of other species, often far out of proportion to their own numbers or biomass. For example, the absence of a keystone predator might release prey species from population control that can result in competitive exclusion among other species. The presence of keystone species often promotes species richness in an ecosystem.

Umbrella species: Umbrella species are species with very large home ranges, comparatively small population densities, and narrow habitat requirements (e.g., northern spotted owl, desert tortoise). Protection of the habitats that support such ostensibly can confer protection the habitats of many other species.

Flagship species: Flagship species are large and/or charismatic species (e.g., pandas, lions, bison, bald eagles) that Arepresent@ the habitat protected. Protection of such species may not protect other species, but it may create support for conservation efforts among voters or financial donors.

Focal species: Focal species are simply species to which particular attention is paid in conservation efforts. Species like the marbled murrelet are neither charismatic nor are they keystones. However, they are the focus of attention in conservation efforts because they are sensitive species within the Northwestern temperate rainforest ecosystem.

Invader species: Invader or exotic species are species that have not evolved within the ecosystem in which they are now found. Some invader species are dangerously aggressive competitors or predators and can cause the extirpation of native species. Invader species include salt cedar, which threatens persistence of native willows, or bullfrogs which threatens persistence of many true frogs in the western United States.

The Role of Research

Research is essential to effective monitoring. Selecting indicators requires research to identify ecosystem elements that correlate in their responses to changes in environmental conditions. Establishing statistically defensible correlations among species or other elements in their responses to the environment is the only effective method for establishing indicators.

Research is necessary for the development, and amendment of conceptual ecosystem models. An incorrect conceptual model can lead to inappropriate adaptive management action. A conceptual model might posit for example, that paved roads are damaging to nocturnal snake populations because individual snakes seek warm places at night to thermoregulate. This hypothesis requires testing. The test would not simply count the number of snakes that become road kills on paved roads. It would assess threats to the persistence of snakes with known population dynamics given that certain numbers of individual snakes will die on roads.